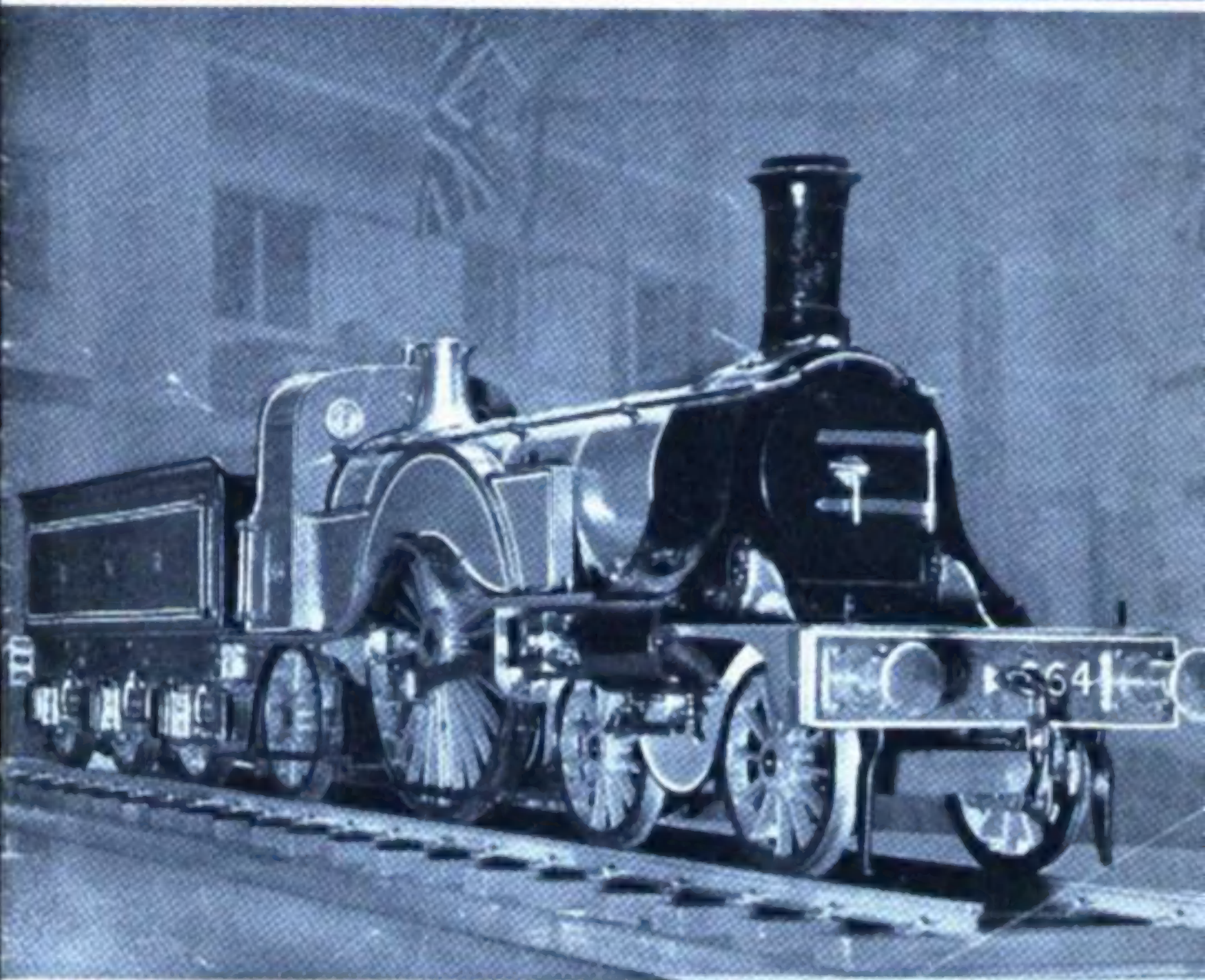
THE MODEL ENGINEER



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THE MODEL ENGINEER

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Our Cover Picture

The locomotive illustrated on our cover this week was exhibited in the Loan Section of the recent Northern Models Exhibition in Manchester. It is a 1-in. scale model of the ever-popular Stirling 8-ft. single-wheeled type of the old Great Northern Railway, and was built about fifty years ago, though we do not know by whom. Some time ago, it came into the hands of Mr. James Moss, of Leigh, Lancs, who has rebuilt it and made a new tender for it.

In its present form, the model reproduces its prototype fairly well, but the safety-valve cover seems to be rather too large, even for the later type acquired by these celebrated engines. The general lines of the handsome prototype engine are closely adhered to, and we should imagine that the model would be very pleasing when at work on a track. The appearance of the model would be greatly improved by a less clumsy white lining, and the tender seems to be painted a uniform green, which is not correct; the border outside the lining should be a much darker green.

SMOKE RINGS

The Late Mr. Bertram C. Joy

WE GREATLY regret to announce the death of Mr. Bertram C. Joy, who is well-known in the professional engine world, having been a consulting engineer for many years, and has also had a lifelong interest in model engineering. Mr. Joy was born in Barrow-in-Furness in 1876, being the younger son of David Joy, of locomotive fame. Both he and his elder brother Basil, who died some years ago, have many claims to engineering distinction in their own right, with many important inventions to their credit, and a keen interest in all types of engines and machinery.

Mr. Bertram Joy designed petrol engines for motor cars and other purposes as early as 1895, and these were among the first engines to be produced in this country. Among other successful inventions of his may be mentioned the valveless diaphragm pump, magnetic oil filters, and air cleaners. For very many years, he has contributed articles to THE MODEL ENGINEER under the initials B.C.J., dealing with experimental engineering and the history and development of i.c. engines. He will be remembered, in particular, by many readers, for his invention of the "Air-Oil" engine, in other words, a model representing in external form and appearance a prototype gas or oil engine, but actually working as a hot-air engine. Of recent years, he has contributed several articles which have revived interest in hot-air engines, a form of power now practically obsolete; his last article, yet to be published in THE MODEL ENGINEER, deals with this subject.

Mr. Joy, despite his many engineering activities, found time for other pursuits, including photography and water-colour painting. He has never joined any model engineering societies, but has always worked as a lone hand. His many inventions will live after him, and will be a fitting memorial to his long and illustrious career in engineering.

Proving Their Worth

ONE OF the difficulties which always faces the judges of a model engineering competition is that of establishing the fact that a *working* model really does work as it should. To establish this at the show is usually next to impossible, and the judges are left with no alternative but to assume that the model *is* a working model and then judge it on its merits as a piece of craftsmanship. But this is not altogether satisfactory, as we understand that ways and means of overcoming the problem are being considered in connection with the preparations for this year's MODEL ENGINEER Exhibition.

Longmoor Railway Jubilee

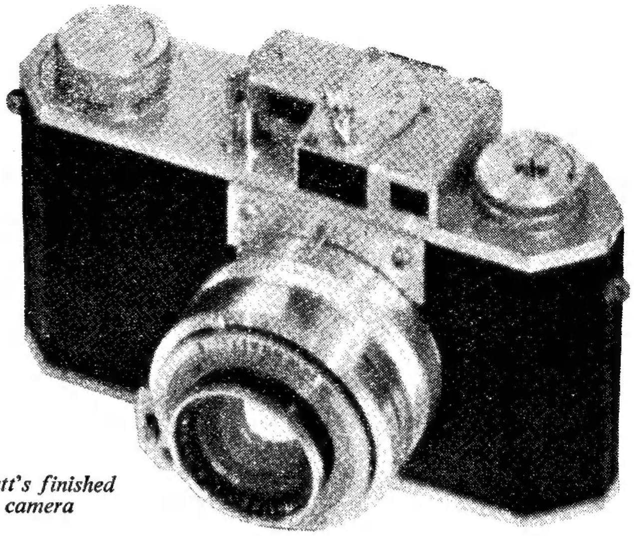
THIS YEAR marks the 50th anniversary of the arrival of the first railway troops at Longmoor, near Liss, Hants, now the Transportation Centre of the Royal Engineers.

On Saturday, September 5th next, a public day will be held when the centre will be open to the public from 1.30 p.m. to 7 p.m. Of special interest will be a joint exhibition of models by the Chichester M.E.S. and the Longmoor Railway Club, as well as the model railway housed in the Signal School.

The late Mr. Bertram C. Joy

A 35 mm. CAMERA and FLASHGUN

By G. Pratt



Mr. G. Pratt's finished 35 mm. camera

BEFORE describing the camera and flashgun which I exhibited in the 1952 "M.E." Exhibition, I must warn readers that each is a successful experiment rather than a perfected design. I approached the construction of the camera knowing nothing more about 35 mm. camera design than can be deduced by gazing at examples in shop windows, and the job was nearly completed before an earlier contributor to THE MODEL ENGINEER explained their inner workings. I would suggest, therefore, that anyone interested in making a similar camera should study mine and then resolve to do better.

The original design is based on the following general requirements :

(1) Rigid lens-mounting to avoid misalignment due to wear or rough use of flimsy folding mechanisms.

(2) Shutter release on body, to minimise camera shake during exposure, and to permit interlocking with film winder to prevent blank frames or, much worse, double exposures, which are very liable to occur when working hurriedly, or with an interested audience.

(3) Large-aperture lens and high-speed shutter—these depend on the depth of one's pocket, and can be dispensed with if the photographer will refrain from working in thoroughly unsuitable conditions.

(4) 36-exposure films to be used in standard metal cassettes.

(5) Rangefinder and depth of field scale to assist focussing on difficult subjects.

(6) The camera must on no account look "home-made," which rules out exposed brass or paintwork, and rows of rivets and screwheads.

Body

This was designed and partly constructed before a lens was obtained, so a large hole was left in the front to accommodate the lens mount. The general arrangement can be seen from Fig. 1, the "chassis" being soft-soldered from various pieces of brass sheet, with stout tinplate for the front casing. Most of the holes in the three horizontal plates were drilled before soldering, and rods passed through them to ensure alignment. The top and bottom cover plates are of $\frac{1}{8}$-in. light alloy, finished matt with fine emery cloth, and the sides are covered with thin black leather, fixed with "Bostik."

Complicated Mechanism

The most complicated part of the design is the film winding and exposure counting mechanism, with the shutter release interlocking. I spent many evenings poring over this, and I should be very interested to see if other readers can suggest a simpler design, which will avoid the many snags, without making the shutter release unduly heavy in operation, or putting considerable strain on the film perforations. If the shutter setting lever were operated by the winding knob, as in commercial cameras, coupling might be simpler, but on my shutter the setting lever has a long arc of travel concentric with the lens (and on the highest speed requires considerable pressure) and this refinement has, with regret, been omitted.

The starting point for this part of the work was the film sprocket, and for anyone interested in designing a camera for 35 mm. film, Fig. 2 gives dimensions of perforations and approximate size of cassettes which I have not seen published before. Fig. 3 gives a plan and sections of the gear which operates as follows :

Assume that an exposure has been made and the film winding knob is turned (clockwise) drawing the film over the sprocket, thus turning the snail-cam (*A*) pressing on pin (*B*) on the underside of the pawl plate (*C*) which pivots on pin (*D*) against the pull of spring (*E*). When the snail completes one revolution, the pawl plate may return under the pull of its spring, until it meets the collar (*F*) on the shutter release and the pawl moves the twenty-tooth ratchet wheel (*G*) clockwise half a tooth. One end of the cranked lever (*H*) will then drop into a tooth space on wheel (*G*) and the other end will drop into the upper ratcher (*J*) (keyed to the winding spindle) preventing further winding.

The camera is now ready for another exposure (not forgetting that the shutter will not open without pre-setting; this does not affect the working of the mechanism, but results in a blank frame on the film which may be overcome by setting the shutter and releasing by the lever on the shutter body before winding on again). When the release is depressed, the collar (*F*) goes down with it, allowing the pawl plate (*C*) to complete its travel until it meets the shutter release spindle, and on the return of the shutter release, the collar stays below the pawl plate, which moves farther to catch under the shoulder of the release spindle. The release spindle cannot now be depressed, and double exposures are prevented. The movement of the pawl plate moves the ratchet (*G*) another half tooth, raising the lever (*H*) on to the "land" between two ratchet teeth, and lifting it from the ratchet

on the winding spindle—and "this is where we came in."

During this cycle of events, the twenty-tooth pinion above ratchet (*G*) moves one tooth, giving one-fortieth of a turn to the forty-tooth wheel, concentric with the winding spindle, moving the exposure counting dial one division. This dial has a friction drive, which I think is self-explanatory, and a small "pip" projects from the face of the dial to give a finger-hold for resetting to zero at the start of a new film.

The lower ratchet on the winding knob spindle has its teeth reversed, although the two are a solid piece of metal, and its pawl (*K*) prevents turning in the wrong direction. When we come to the end of a film, and wish to return it to its cassette, pawl (*K*) must be lifted from its ratchet and the pawl plate-pin (*B*) must be moved clear of the snail-cam so that the sprocket can turn backwards. This is accomplished by a half turn of lever (*L*) on top of the body; the lower end has a shorter lever and pin which moves the pawl plate anti-clockwise and the pawl plate catches the pin on the end of pawl (*K*), lifting it clear of the winder. The one snag in this part is that the release lever cannot be operated when half-way through the winding operation, so if the film is wound on to the very end it may be impossible to rewind without a trip to the darkroom. This has never caused me any trouble, and I can usually steal one extra exposure after the nominal 36 are shown on the dial, but it would be risky to attempt more.

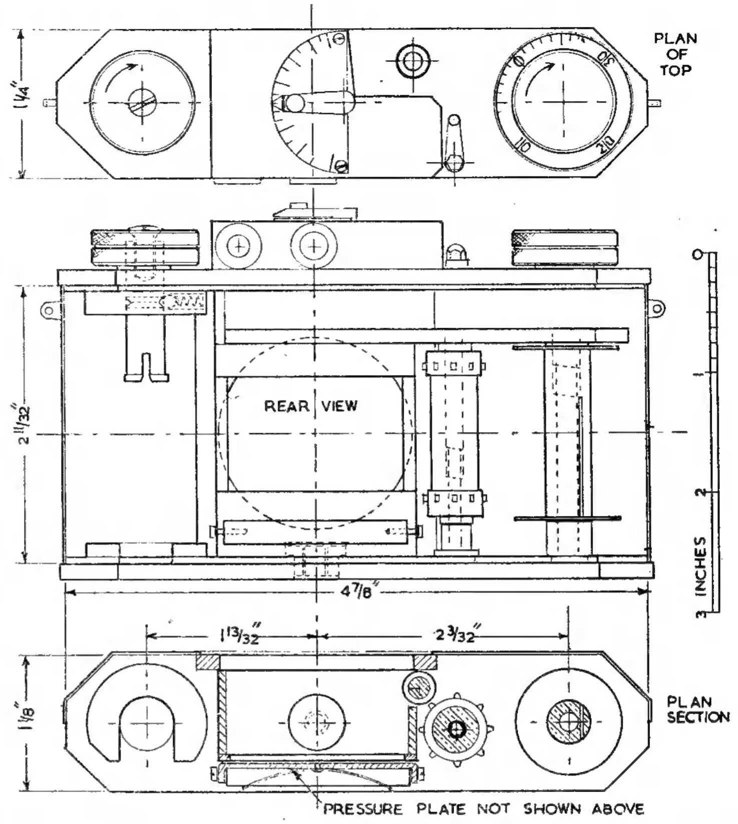


Fig. 1. Three views, showing the general arrangement of the 35 *mm. camera*

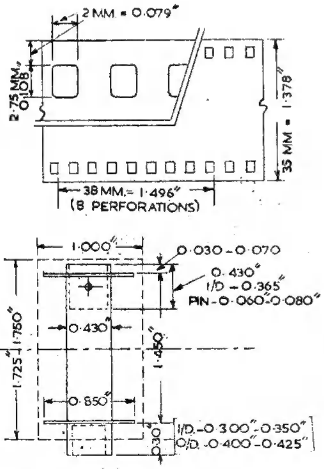


Fig. 2. Approximate dimensions of film and cassette

The films are numbered-up for thirty-eight frames, but my first exposure is usually a little past number one.

After this maze of ratchets, levers and so on, all squeezed into one corner, the rest of the body is pretty straightforward. The rewind spindle is waisted, and its bush fitted with a sprung ball to hold the knob a little off the top of the case, so that it may be pressed down slightly and turned to open or close the cassette (if a type which will open is used) or pulled out to permit removal of the cassette.

For those with no experience of films of this size, I should explain that they may be bought in thirty-six exposure lengths, with ends ready trimmed, for dark-room loading into a cassette (the price being about 1s. 9d. more than a "one-twenty" size film) or in longer lengths uncut. Alternatively they are sold on a spool, in a tinplate cassette having a black felt or velvet lined slit, out of which the film is drawn, but these cassettes add about 4s. 6d. to the cost of the film. For some months I reloaded this type of cassette (against the manufacturer's recommendations) but after the first use, dust and grit in the felt light trap is very liable to cause scratches, which show up very badly in enlarging. I then bought a cassette which is formed of two concentric sleeves, each with a wide slit. When the slits coincide the film passes through without danger of scratching, but a half turn of the inner sleeve renders the cassette light-tight, the loose end of the film passing between the two sleeves. The opening and closing is accomplished from outside the camera by pressing down the rewinding knob which causes the spool to engage with dogs on the inner sleeve so that the sleeve turns with the spool for half a turn. The design is patented, so I cannot give instructions for their construction, but I can say that the amount of work entailed is fully reflected in the price of the commercial article.

The back of the case, which must be light-trapped all round, was not considered until the remainder of the

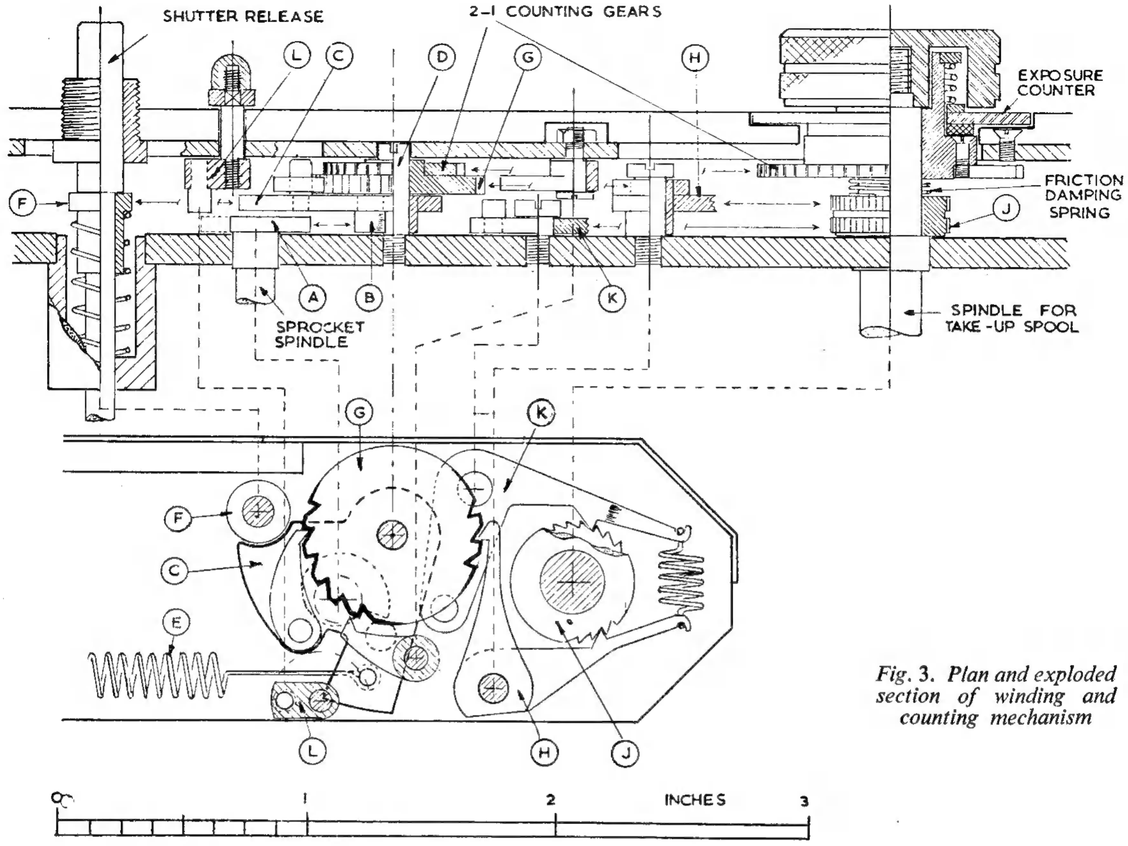


Fig. 3. Plan and exploded section of winding and counting mechanism

work was completed, and in consequence its internal appearance leaves much to be desired. It is constructed of tinplate on a framework of brass angle, which is filed down where necessary to clear various obstructions and where space was available, further angles were soldered inside the body to form a groove into which the framing of the back will fit. (These angles are omitted from Fig. 1.) One end of the back is hinged, and the other end fitted with a pair of small catches which engage in holes in the top and bottom plates. The catches or bolts act similarly to the connecting-rods on a horizontally-opposed twin-cylinder engine, the crankshaft being a flanged disc (with two crankpins) set in a bush in the back and slotted on the outside for turning with a coin; one-third of a turn moves both bolts in or out.

The dural plates which finish the top and bottom of the case are located by the bushes for the rewind spindle and tripod respectively, and fixed with 10-B.A. countersunk screws, those on the top being hidden under the rewind knob and exposure counter.

Viewfinder and Rangefinder

The block containing the viewfinder and rangefinder was sawn and machined from a solid chunk of metal, cast in a cocoa tin mould, and fixed with screws from the underside of the top plate. The ingredients of this metal were various oddments of scrap light alloy, and it turned out rather too crystalline to machine well, but at the time I had no drawn bar large enough.

I would much prefer to have the rangefinder and viewfinder combined but I had no idea how to set about it until I read, too late, the articles by a more expert contributor to the "M.E." a few months ago. If I could find where to get the three lenses needed, I should try remaking this part and coupling it to the lens focussing. My viewfinder lenses are plastic, obtained by purchasing a small moulded viewfinder intended for some small commercial camera. The semi-transparent fixed mirror and the surface-silvered moving mirror were from a purchased rangefinder. In the very small space available, I had to keep the construction much simpler than the de-luxe specimen described in the article mentioned above, and its accuracy is correspondingly reduced. I have, however, used it as a viewfinder to take close-up photographs (requiring "spot-on" focussing) of a flower while holding the camera by hand, the method being to set both lens and rangefinder to 1 ft. 6 in. focus and moving the camera backward and forward until the rangefinder images coincide. Anyone who saw the camera in the Exhibition may have seen a print of one of these photographs, mounted on the stand, which had been enlarged by ten times (lineal) to give a print larger than life without serious loss of definition.

All the external steel parts of the camera are stainless, and the pawls, ratchets, etc., are case-hardened.

(To be concluded)

L.B.S.C.'s Lobby Chat

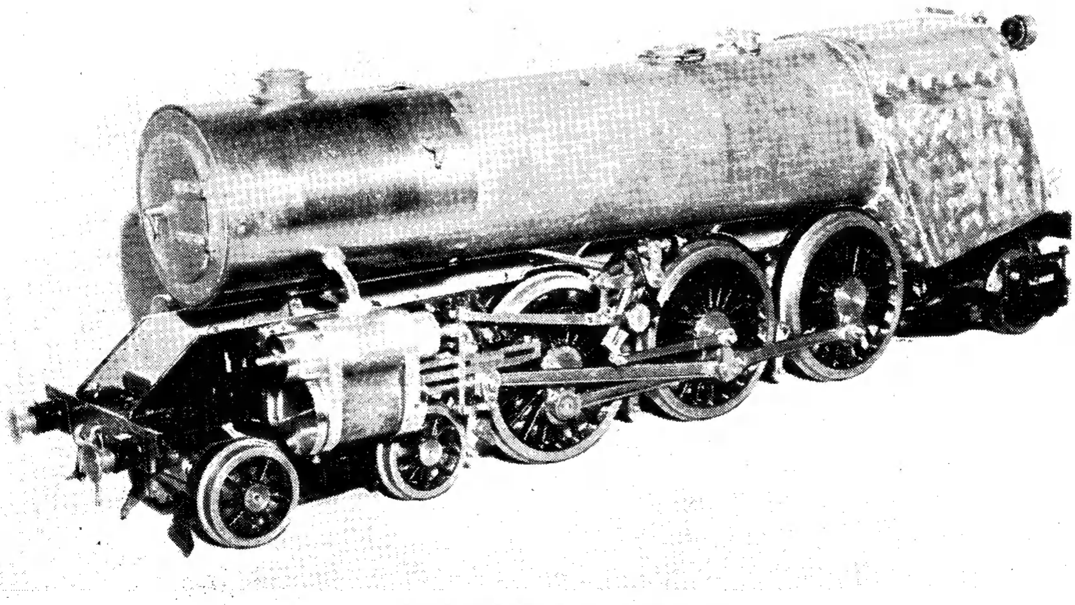
● A SOUTH AFRICAN "BRITANNIA"

THIS week, by the good rights, there should have been another instalment of the *Britannia* construction serial; but will all builders please accept my sincere apologies for delaying it until next week? The trouble is, that I haven't finished the necessary drawings. Scheming out the details, and making the drawings for the little job which formed the subject of last week's notes, took up far more time than I anticipated. I do everything myself, without the least assistance—even to washing the gasoline buggy, and cleaning clinkers from the firebox of our domestic boiler, two or three times a day, thanks to the awful apology for coal supplied by the National Coal Board at an awful price—and there is a limit to my physical capacity. I'm not pleading ill-health; it is just that the old human locomotive is hauling the longest possible train at the highest possible speed, and can't pull another coach, or go any faster. Nuff sed!

Letters from good folk who are building the engine, still come rolling in from all over the world; and one received a couple of days ago, time of writing, deserves a special mention. The writer was Mr. W. Donnelly, of Modder East, in the Transvaal, whose version of *Britannia* is a first attempt, and he forwarded the reproduced photographs. The engine part is made to words and music, but our friend has made a little variation in the boiler accessories, partly due to the fact that he is now "running ahead of schedule," and partly to suit local conditions. He has already made his grate, but whilst using my "standard" firebars, has spaced them ¼ in. apart, as the South African coal has an ash content of from 30 to 40 per cent., and needs plenty of space through which to fall out. As the rate of firing is necessarily high, he has put on a much larger firehole door than specified for British coal. The boiler fittings, while being of the "regulation Curly pattern," are arranged differently, as given for other types of engines which I have described from time to time. Mr. Donnelly also proposes to lag the boiler throughout, and has made the smokebox larger in diameter, so that the cleading plate will be flush with it. He adds a word of praise for the "Wilwau" castings.

Blowdown Valves

It will be noticed that our friend has fitted two of the screw-type blow-down valves at the bottom of the backhead. This will also be contrary to specification, for I am using an "Everlasting" blowdown-valve, exactly the same as on the full-sized engine, and attached to the throatplate in the correct position. It will be operated by an outside handle, as in full size. The "Everlasting" type of valve is about the best kind ever produced for locomotive boilers, large or small, as it has no screw threads to become choked with scale and other residue, and gives a direct full-bore blowdown



Good work for a first attempt!

with one small movement of the handle. If properly made, it can neither leak nor stick; and the higher the boiler pressure, the less likelihood there is, of any leakage taking place. Incidentally, any builder of a little *Britannia* who is up to instructions and awaiting another job, can go ahead and make a weeny "Everlasting" valve, as per the instructions given in the *Doris* serial.

Regarding the position of a blowdown valve, let us look back over the years, to the days when I earned my bread-and-butter (good white wholesome bread, and real fresh butter, at that !) in the service of the London Brighton and South Coast Railway, of blessed memory. All our engines used to have one day's rest in seven—we called it the "shed day"—when the regular driver and fireman would wash out the boiler, and do little odd jobs for themselves, such as packing glands when necessary, making swabs and trimmings for lubrication (I could—and will, later on, if the K.B.P. has no objection, initiate the non-railwaymen readers of these notes, into some of the ritual of the enginemen's craft) and umpteen other little things that no driver or fireman would ever have dreamed of asking the shed staff to do. Things are different now—and the shocking condition of most of the present-day locomotives, is a sound testimonial to the way things have—ha, hum ! "progressed !" Anyway, in those days, few engines were fitted with blowdown valves. The "Everlasting" valve hadn't been invented, and the only thing available was a glorified plug cock. Most folk who aren't prejudiced, will appreciate at once, that a plug cock in the firebox casing, placed low down where the mud and scale accumulates, would be stuck solid after the first run ar two ; and such was the case.

A Ticklish Job !

Neither Stroudley, nor the elder Billinton, fitted blowdown cocks ; but right down close to foundation ring, was a series of washout plugs. The usual arrangement was to have three in front, and three behind; they were arranged so that the end ones were in line with the water spaces at the firebox sides, and the others in the middle of the throatplate and backhead. Where a firebox could be got at, through a hole in the frame, or if it came below the frame, side plugs were fitted as well. To empty a boiler, we used to slack off one of these plugs, which were screwed in on a taper thread, tie a piece of "tarband" (tarred string) around the square head, hold the loop end of a washout rod against it, and wind the string around the lot. Then, holding the other end of the rod, and carefully standing well out of the "line of fire" (says Pat) we turned the plug by aid of the rod, until it shot out, and let loose the contents of the boiler. If the latter was at all warm, one of the plugs on the backhead, or the smokebox tubeplate, was taken out as well, and the nozzle of the washing-out hose put in, so that a stream of cold water mingled with the hot water in the boiler, and cooled it gradually as the boiler drained. This saved potential tube and stay leakage, by avoiding rapid contraction.

Nothing Doing!

Now, readers will probably be surprised to learn, that sometimes, when the plug came out—especially if it were in the throatplate—nothing happened ! Investigation at once proved that scale had accumulated around the plug, and blocked the "entrance to the way out." Naturally, a few hefty prods with a long steel washout rod, soon shifted the muck, and started the water flowing ; but bear in mind that this happened *with the plughole a little above the foundation ring*. In cases where I have specified screw-down blow-off valves, I invariably arrange them a little above the foundation ring, because all the mud and scale naturally settles *on the ring itself* ; and if the outlet were arranged in the actual ring, the scale would gravitate into it as easily and quickly as a bit of soap finds its way into the plughole of the domestic bath, and would block it solid. In places where the water is very hard, or is chalky, as at my old home at Norbury, even the external screw-down valves, set above the foundation ring as above described, failed to discharge the contents of the boiler when opened, and the valve had to be removed, and the waterway cleaned with a piece of wire, after all the steam had gone from the boiler. The "Everlasting" type of blowdown valve which I am specifying for *Britannia* (thanks to Mr. F. S. Lovick-Johnson, managing director of the Everlasting Valve Company, who kindly supplied the necessary information) avoids all this. It would take a dickens of a lot of dirt, to choke the straight waterway; and as the valve is so easily operated, it can be tested every time the engine is in steam.

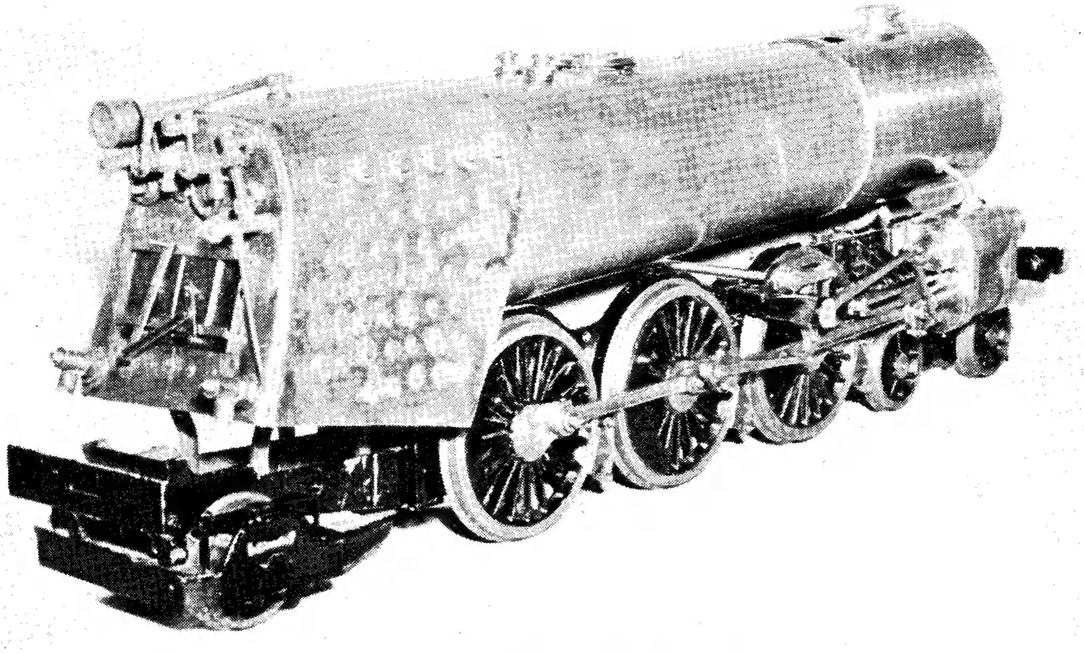
I might mention another fault which frequently happens to a screw type of blowdown valve, even when placed in the position I specify. When operated, some of the dirt is blown into the threaded part of the valve-pin; and unless this is very frequently taken out, thoroughly cleaned, and lubricated with something really substantial, such as a mixture of cylinder oil and powdered graphite, it will probably be found to have set solid, on the very next occasion when one needs to use it.

Mr. Donnelly concluded his letter with a few words of kind appreciation for the easily-followed notes and drawings for the little *Britannia*, and I thank him most sincerely; adding my hearty congratulations on the fine way in which he has interpreted them, all the more commendable in view of the job being a first shot.

Not Recommended !

Several readers who are building *Britannias* and haven't yet reached the stage of fitting the cylinders and motion, have asked for a drawing of a suitable slide-valve cylinder, and what modifications would be needed to the valve-gear, if these cylinders are used. My honest advice is, to use the piston-valve cylinders, and the valve-gear as given ; no advantage, either in construction or operation, would be gained by using slide-valve cylinders. As a matter of fact, the slide-valve cylinders, with their separate steam chests and extra flat joints, array of studs, and so on, constitute a much longer job. The valve-gear would do without much alteration, it is true ; but the return crank would have to lead the main crank instead of following it, and the connections at the top of the combination lever would need reversing.

What apparently "scares off" the readers who ask about slide-valves, is the stupid tales about "super-precision" fit, supposed to be needed for piston-valves. The truth is, that there is no more trouble in fitting piston-valves to a steam-chest liner, than in fitting the pistons to the cylinder bore; and you can take that as gospel, from your humble servant's own actual personal experience. I've made enough locomotive cylinders, goodness only knows; far more than anybody else who ever wrote for this journal. Now I'll say right here, that if a piston-valve were ground (it couldn't be turned) to such a fine limit that the heat of one's hand would expand it sufficiently to prevent it from entering the liner bore, *it would be utterly useless*. Surely ordinary common sense would recognise at once, that as soon as the steam got to it, it would seize up solid. I know more than a little about precision fits, by virtue, again, of actual personal experience, in view of the



Mr. W. Donnelly's South African "Britannia"

fact that I had charge of a munition shop making aero-engine parts, during the latter part of the Kaiser's war. So did two or three of my girls, incidentally, when they put small parts made to just the bare tolerance, into hot or cold water, before taking them to pass the viewer! But she was up to their larks, because she always let everything stand for an hour or so, in order to be at the temperature of the room, before "miking" them. Thus it was that we had very few rejects when the goods were delivered.

How it is Done

The manner in which I determined the correct fit for a piston-valve, was simplicity itself. I don't profess to be a witch-doctor, and the result of my experience is at the service of readers of these notes, with full explanation of the "how" and "why". All I did, was simply to bore a liner, and fit a piston-valve to it, *at working temperature*. Nothing "clever" about that at all; ordinary common sense indicated that it was logical. When the valve and liner cooled off, application of a "mike" showed immediately, how much clearance was necessary, when the metal was machined at ordinary temperature, to ensure that the piston-valve would be steamtight, when properly lubricated, under ordinary working conditions. If three or four very fine grooves, say about 1/64 in. wide and about 3/32 in. deep, are made in the bobbins, they will retain enough oil, to keep the piston-valves tight against steam leakage. This idea is as old as the hills; these grooves, known as "labyrinth packing," were known and used by the very early builders of steam engines, long before a locomotive ever ran on rails, or on the road. However, there are no grooves in the piston-valves of my 2½-in. gauge 4-6-2 *Fernanda*, and when she was running yesterday afternoon (time of writing) I stopped her at the bottom of the bank, and restarted with as much steam as the cylinders would take without slipping the wheels, just to see if there were any signs of blow. Nary a scrap! She started readily, with terrific deep-toned cracks from the chimney, the sound being exactly the same as made by pulling a cork out of a bottle; no wheezing in between. This is just as it should be, and just what one would expect from an engine which has a Great Western link motion, and the *true* Swindon valve setting. Did I hear a loud cheer from our Technical Editor? As mentioned when describing the new tender, the engine is eighteen years old, and has done some hard work. The boiler, made similar to that described for *Fayette*, has never shed a tear, or failed to steam under any condition of service, from the day it was made and erected.

Buzz-z-z-z!!

A new reader, writing for some information about a *Tich* that he is building, says he had an experience that puzzled him somewhat. Waiting for a train at a provincial station, he went to take a close look at a tank engine which had just pulled in with a local train, when suddenly she started to make an awful vibrating noise, which seemed to shake the whole station, and the atmosphere all around it. He was hastily backing away, thinking that something was going to happen, when the noise ceased as suddenly as it began. Nobody seemed to take any notice, and he asks if I can give any explanation. He said the blower was on fairly hard, when the noise started; and when it ceased, it was either shut off, or only on a very little, so surmises that the vibration came from the firebox, but is curious about the cause.

Our friend could have had the matter settled right away, if he had asked the fireman. The noise came from the firebox all right, but it wasn't the firebox that caused it—it was the fire! There was a hole in it somewhere, and the blower was

drawing cold air through the hole. The stream of cold air mixing with the products of combustion (sounds very scientific, that ! !) sets up the vibration; *why* it does so, I don't know, though maybe Professor Boreas Blustering, well known for his concise and lucid explanations as why air currents moving at certain speeds, and in certain directions, are prone to dislodge roofing tiles, chimney-pots, bowler hats, and turn umbrellas inside out, might perhaps be persuaded to deal with the matter in a half-hour talk on the Third Programme. Anyway, it *does*; and your humble servant's method of curing it, in two wags of a dog's tail, was a couple of pokes with the pricker, though it very seldom happened on our engines. We were taught on the L.B. & S.C. Ry. to run with a thin fire, saucer-shaped, so that no cold air was liable to be drawn in around the sides of the firebox, and cool the plates and the inside stay-heads. Coal consumption was exceedingly low, and occasionally the fire would be so thin in the middle, that a hole would form, and start the unearthly noise, when the engine stopped at a station. I never knew it to happen when running.

Boilers that Sing and Jazz

All boilers are prone to make a noise, but it isn't the boilers themselves; it is the water inside. Now I am writing this, in the first-floor back room of our hacienda, which is directly over the top of my workshop, in which is the No. 3 " Ideal Classic " boiler which keeps our radiators hot, and supplies the domestic hot water. Incidentally the latter is not heated direct by the boiler; the drum-type hot-water tank which feeds the sink and bath taps, has another cylinder inside it, through which the hot water from the boiler circulates, and heats the contents of the tank without actually coming into contact with it. No fur or scale is deposited in the tank, as it never boils; but the water is always very hot. A few minutes ago, I went downstairs to take a look at the fire. It was good and bright, and the boiler was singing away like nobody's business. When I grabbed the handle of the firehole door, I could feel the vibration.

The square firebox of this " Ideal " boiler is made of fluted cast-iron, same as the outer shell. There are, of course, no stays, as the boiler does not work at any pressure, except the few pounds caused by the weight of the water in the radiators upstairs, and the odd gallon or so in the balancing tank. Just to tickle my fancy, the plumber who put in the installation (one of my " fans ") put a brass direct-loaded safety-valve on top, set to blow off at about 10 lb., and a " steam gauge " in the shape of a Rotothermn thermometer, the needle of which usually hangs around the 160 mark; so we look quite important! The boiler is as solid as a rock, *and the humming and vibration are caused wholly and solely by the water inside it.* The same thing applies to large steam boilers of the Cornish, Lancashire, and Galloway types, which were plentiful when I was young.

The cast-iron top of one of our Primus stoves, is distorted by years of heating, and when the domestic kettle is placed on it, the kettle will not stand firm, but rocks. A few minutes after the kettle is filled with water and placed on the lighted stove, it begins to sing, and vibrates; then finally, when the water boils, the kettle starts to do a jazz dance on top of the distorted stove-top. The kettle has no firebox, nor tubes, nor stays; it is merely a thin aluminium shell, incapable of any movement of its own free will and accord; all the movement comes from the water inside, which, when boiling is what our scientific friends would call " in a high state of ebullition." Now it doesn't need a Sherlock Holmes to deduce, that if a quart of water, heated to boiling point, can cause such a commotion in an inanimate metal vessel, what sort of a carry-on will be happening inside a full-sized locomotive boiler containing several hundred gallons of water, heated to a temperature half as much again ? Tales of " vibrating fireboxes " and so on, are just simply moonshine, as the above simple analysis shows pretty clearly; any noise and vibration in any boiler of normal design and sound construction, is caused by the water inside it, and nothing else. What applies to full-size boilers, applies also to small ones ; facts are facts !

The Britannia Tubular Bridge over the Menai Straits, the railway bridge over the St. Lawrence River at Montreal, and the upper footways of the Tower Bridge, are all of box-girder construction, which any mill-wright will tell you, is one of the strongest forms of construction known. The crown stays of the boilers described in these notes, in conjunction with the wrapper sheet and the top of the firebox, *combine to form a box girder.* A nod is as good as a wink to a blind horse ! It should be obvious to all unprejudiced persons, that girder crown stays actually add to the evaporative efficiency of the boiler; because any heat carried by convection from the firebox crown, is dissipated in the water surrounding the girders. Everybody knows how Curly boilers steam ; experience still teaches ! Girder crown stays were used on the L.B. & S.C. Ry. engines; huge affairs bolted to the firebox crown, and slung from the wrapper sheet by flexible supports. Old Billy Stroudley knew his job all right !

Another Dose of Flu

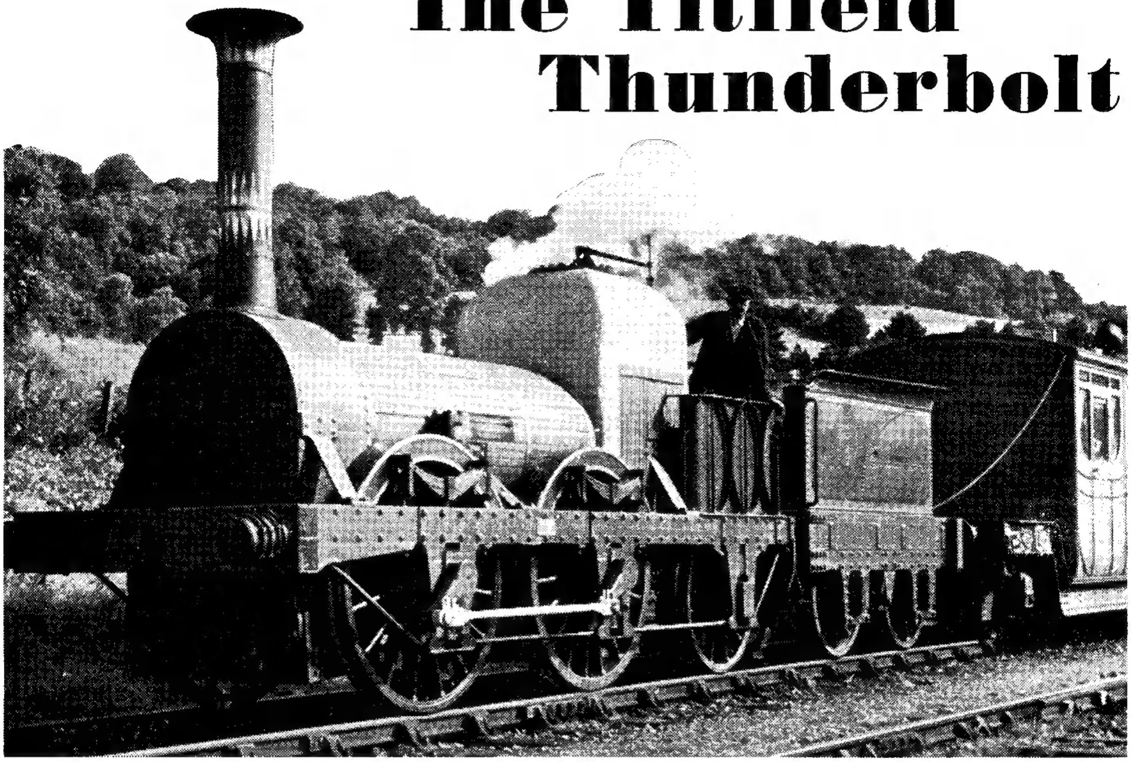
I was rather interested in the recent correspondence on the pros and cons of fluorescent lighting. As regular readers will maybe recall, I installed an 80-watt 5 ft. lamp in my workshop, to " bring daylight in at night." This was a complete success; all the tales that I heard about distortion of work, stroboscopic effects, and so on and so forth, proved groundless. I found the clear white light a great aid when working at night; and as I sometimes keep on almost to the " wee sma' hoors " (otherwise I would not get anything done) the lamp got plenty of exercise.

When it was first put up, the lamp was in a trough reflector; and though this was O.K. for the machines in range of its rays, the ceiling of the workshop was always in dark shadow, and there wasn't much illumination for anything out of range. I therefore took the lamp out of the trough, and fixed it in two home-made clips about 6 in. below the ceiling, putting the " works " of the lamp (condenser, choke, etc.) on top of the wooden beams which carry the counter-shafts for lathe and milling machine. This was a great improvement; I still had bags of light for the drill, shear, linisher, grinder, and erecting bench, and the white ceiling diffused the light, so that no part of the workshop was in shadow.

However, trouble came in winter-time, when the mains voltage would drop to 180 or thereabouts. The lamp would flicker, and sometimes go out altogether, although O.K. at the full voltage; so I got on to my good friend " Bro Osram," about the possibility of getting a transformer to boost up the voltage. He said that maybe a new flu-tube would improve matters, and brought one along to try, also a meter for testing the light intensity. The new lamp certainly *did* improve matters; and while here, our worthy friend suggested that maybe another similar lamp, at right-angles to the first

(*Continued on next page*)

The Titfield Thunderbolt



A WELL-PRODUCED film, presented by Ealing Studios, has been generally released and seems to be something of a box-office success. It is a railway story " with a difference," and doubtless will be enjoyed by any readers who claim to be railway enthusiasts. The " hero " of the film is an aged 0-4-2 locomotive which is taken out of a local museum to replace an engine which is wrecked just before the " Titfield " branch is due to accelerate the train service.

The actual engine used in the film is our old friend the *Lion*, built in 1838, as No. 57 on the Liverpool and Manchester Railway. In 1859, she was sold to the Mersey Docks and Harbour Board, who used her as a stationary boiler for supplying steam to pumps, for a great many years. In 1928, *Lion* was presented to the Liverpool Engineering Society, and was taken to the L.M.S. Railway shops at Crewe to be reconditioned and restored to her original state. She was running at the Liverpool & Manchester Railway Centenary exhibition at Wavertree Park in September, 1930. She then retired to a specially prepared pedestal in the circulating area at Lime Street Station, Liverpool, which is her legitimate home.

Came 1937 and she was out again, in steam, making her first appearance as a film star, this time at Swindon where she took part in a film in connection with the Great Western Railway's centenary. In September, 1938, she was once more in steam, an exhibit at Euston station as part of the London & Birmingham Railway Centenary celebrations.

During the war, she was kept at Crewe works, but subsequently returned to her pedestal at Lime Street, Liverpool.

As the " Titfield Thunderbolt," she gives what is generally regarded as by far her best performance; but, in certain quarters, there is a growing feeling of dismay at the idea of a valuable locomotive relic being used in such a manner. We can nly hope that every possible care ¿is being taken to ensure that *Lion* shall suffer no damage as a result of her entertaining exploits.

" L.B.S.C's " Lobby Chat

(*Continued from previous page*)

one, placed directly over my workbench, would not only obviate the necessity for a spotlight over the latter, but give an even bright light all over the room. He offered to supply the fittings, which I eagerly accepted. I put in a switch and connections, and a couple of ceiling clips, similar to those already in use; and when " Bro. Osram " brought the lamp and fittings, it was only a few minutes' work to put them up.

There was a temporary disappointment; " Bro. Osram " had bumped the carton against the doorstep on entering, and the " ping " from the lamp inside it, was a signal of trouble, for all we got was a flicker like summer lightning; but on trying my old lamp in the holders—Bob was our uncle ! Two days after, the local branch of the G.E.C. delivered a replacement lamp; and now—well, " illuminations for the Coronation " are an also-ran. The two lamps form a T on the ceiling; and when they are both going, the light is sufficient to find a 12-B.A. screw dropped anywhere on the floor. I'd just hate to go back to ordinary illumination again.

A set of door chimes

Constructional details of a useful domestic appliance

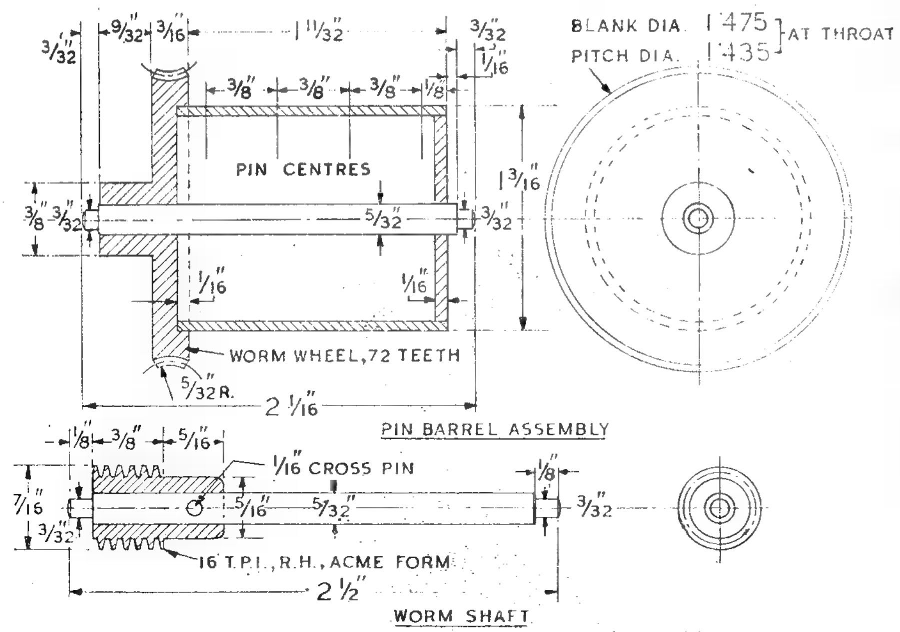
By " Artificer "

THE pin-barrel, with its worm wheel, is fabricated as shown in the drawing, the parts being sweated together if desired, though I have found it quite satisfactory to use press fits, with no additional fixing. Brass tube may be used for the barrel, but I found an old bronze bush in the scrap-box which served the purpose after skimming up inside and out. A disc of $\frac{1}{16}$-in. sheet brass was drilled and reamed 5/32 in diameter in the centre, then mounted on a pin mandrel with a clamping nut and turned on the outside edge. An interference of about 0.001 in. was allowed here, and also on the recess of the worm wheel, into which the barrel fits.

If a worm wheel of approximately correct size and number of teeth happens to be available (note that it is not necessary to work to an exact ratio of reduction) it can be adapted for this job, but will probably entail some modification in the method of mounting. In the case of a plain disc wheel with no bosses, it will probably be best to make the barrel complete with two end discs, and attach the worm wheel to it with two or three screws. Whatever method is employed, however, it is essential that the entire assembly should run truly when mounted on its arbor. The wide " throated " worm wheel shown is not absolutely necessary, as it would carry far more working load than it is ever likely to be called upon to do in driving this mechanism; it is probable that a thin spur wheel, adapted to act as a worm, would carry the load and give reasonable wear—at least for the first fifty years !

It is not at all difficult to produce a worm wheel of the type shown, however, and if one is going to do so, it is just as easy to make the throated type as one having less bearing surface on the teeth. Hard brass is a suitable material, though medium bronze or gunmetal is better; the harder bronzes are more difficult to machine, and hardly necessary for this work. The blank should be turned to the outside dimensions shown; it should be noted that the only practicable way to measure a worm blank is over the throat, though this may present a difficulty, as an ordinary micrometer cannot be applied here. But in practice, such meticulous accuracy is not necessary unless the worm dimensions, and also the centre distance of worm and wheel, are rigidly fixed. Worm gears are capable of accommodating slight dimensional inaccuracies, and moreover, when they are produced by a hobbing process, the hob can be arranged to finish the top of the teeth, and thereby the depth of feed of the hob will adjust the final outside and pitch diameters simultaneously. Thus it is advisable to leave the blank a few thousandths of an inch oversize.

Continued from page 405, *April* 2, 1953.



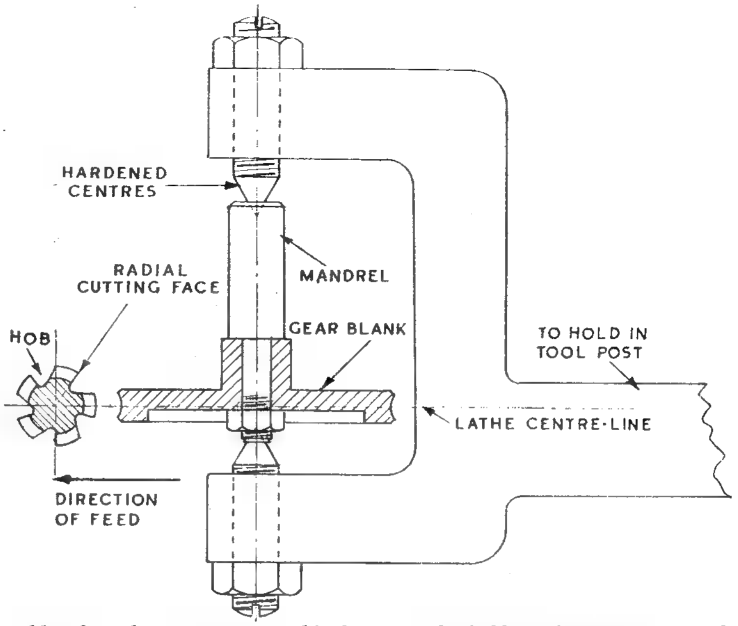
Cutting the Worm Wheel

To ensure positive and accurate results, it is advisable to gash the teeth of the worm to about three-quarters of their finished depth before hobbing. Any of the well-known methods of gear cutting, which have been fully explained in THE MODEL ENGINEER on many occasions, can be used for this operation. As the teeth of the worm wheel have to be " skewed " to suit the pitch angle of the worm, the relative angle of the cutter to the wheel blank axis must be adjusted accordingly. Make certain that this is in the right direction, or in other words, to suit the " hand " of the worm ; however, if a mistake *should* be made in this respect (and believe me it is only too easy to do so, as I know from bitter experience !), all is not lost—the worm can be made to suit, and the direction of rotation of the motor reversed. This, by the

way, is one very good reason for completing the cutting of the worm wheel before making the worm.

An ordinary fly-cutter, formed to an included angle of 29 deg., can be used for the gashing operation. Accuracy of form is not important, but the cutter should obviously be narrower than the finished tooth form.

It is advisable to cut the teeth of the worm before attaching it to the pin barrel, because this enables it to be mounted on a stiff mandrel, only the end of which is turned down to 5/32 in. and fitted with a nut for mounting the blank. This mandrel should be turned between centres, so that the wheel can be left mounted on it for hobbing, a suitable fixture, with point centres, being made to carry the arbor vertically in the toolpost, or on the vertical-slide. The holder shown in the drawing was adapted from an old fly-cutter frame, made for ornamental turning.



Holder for arbor carrying gear blank, set up for hobbing the worm gear in the lathe

Hobbing

Unless one is lucky enough to possess or obtain the use of a hob of suitable size and pitch, it will be necessary to make one. Although tool-steel is obviously desirable for a permanent job, a case-hardened mild-steel hob will serve the purpose quite well, unless a material which is specially difficult to machine has been used for the blank. I have used hobs of this type and found that they are not only serviceable, but also much more durable than might be expected; on one occasion I made over 100 brass worm wheels with no appreciable sign of the hob wearing out. The thread of the hob is screwcut to the same pitch and form as the worm, also to the same core diameter, but it is advisable to make it a few thousandths of an inch larger on the outside diameter to give bottoming clearance.

About five flutes in the hob, not necessarily equally spaced, are advised; they should be cut well below the thread depth, but not too wide, and the cutting face should be on the radial line, so as to produce neither positive nor negative rake. Backing off is not necessary, and would not be very useful unless the sides as well as the tops of the threads were relieved; the finish of the threads, however, and also the cutting edges of the flutes, should be perfectly clean and sharp.

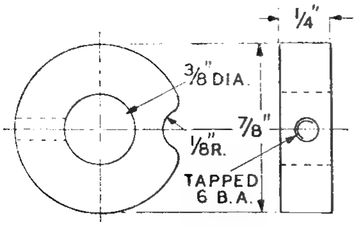
The blank should be set up on its mandrel between the centres of the fixture, and adjusted so that the centre of the throat is exactly at lathe centre height. It should turn freely on its centres, but without any trace of slack. The hob may be run at the top speed of the lathe, and once engaged with the gashed teeth, will rotate the blank and generate the teeth as the feed is gradually applied to the cross-slide. Side movement can also be applied occasionally, by the top-slide or saddle, and this helps to distribute the cutting over the length of the hob teeth, instead of localising it in one spot.

The gashing operation is sometimes dispensed with in cutting small worm wheels, the hob being relied upon to feed the blank round, but although this is often successful, it is a rather chancy business, as a certain amount of slip may take place in the first stages of the hobbing, and thus result in failure to " pick up " the teeth accurately, so that marred or at least uneven teeth are the result, or the wheel may turn out to have a different number of teeth to that intended. In the present case, a few teeth more or less do not matter, and readers who care to may try this method, but I advise making one or two spare blanks in case the first attempts are not a complete success. All this has been discussed in THE MODEL ENGINEER on several occasions in the past, and the many ways of hobbing have been described in detail, including the method of driving the blank *positively* while it is being hobbed, which is quite sure and accurate.

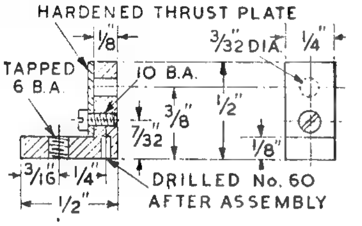
Tapered Hobs

While on the subject of hobbing, it may be observed that it is an advantage to use a *tapered* hob, which is cut and fluted in the normal way, except that it should be made long, about five or six times the diameter, and the tips of the teeth tapered down like an ordinary tapered tap, to the core diameter, leaving only a short parallel portion at the large end. The advantage here is that the cutting can be started at the small end and the feed applied in the axial plane of the hob (i.e. sideways) instead of radially, by the cross-slide. The initial cuts are taken to the full width of the teeth and are deepened as the blank is advanced towards the large end of the hob, but the load on the latter is reduced and it cuts cleaner, because it does not have to form the entire surface of the teeth simultaneously. This may not be very important on small fine-pitch gears, but is very useful when the teeth are deep and coarse.

It may also be observed that hobbing is equally practicable for spur and skew gears, provided angular adjustment can be made to suit the pitch angle of the teeth, and the feed is applied at right-angles to the hob axis, in other words across the tooth face. Hobbing, if properly carried out, produces highly accurate gears, of guaranteed concentricity to the centres on which they are mounted. No doubt these hints



FIBRE CAM



WORM SHAFT BEARINGS   2 OFF

are ancient history to many readers, but they may be helpful to others of less mature knowledge or experience.

Barrel Arbor

The pin barrel assembly, when finished, is mounted on a 5/32 in. diameter silver-steel arbor, the ends of which are turned down to form 3/32 in pivots. It is not necessary for the barrel to be a very tight force fit, as it does not have to transmit a drive through the arbor, but it should be tight enough to give end location, and, of course, the whole assembly must run truly on its pivots. In the absence of an *accurate* collet chuck for holding the arbor when turning the pivots, the method, already referred to, of making a thin bush, bored to fit the steel rod, which is then held by tightening the chuck jaws, can be recommended. The pivots should be as highly finished as possible, though the burnishing process applied in the best horological work is hardly necessary; they should preferably be made a little on the tight side for their bearing holes, and the latter carefully broached to fit them. These methods are applicable both to the barrel arbor and also the worm shaft, which is also made from 5/32-in. silver-steel. It is not necessary to harden the pivots when this material is used.

Worm

This may, with advantage, be made at the same time as the hob, while the lathe is set up for cutting the thread. Mild-steel is a suitable material, and case-hardening is desirable but not absolutely necessary. The boss is turned down slightly below the core diameter of the thread, and the bore, which must, of course, be truly concentric, is reamed to a light press fit on the arbor, where it should be secured by either a taper or parallel cross pin, carefully fitted—not bashed in with a big hammer! The same applies to the mounting of the skew gear on the worm shaft; exact location of these gears is not important, but they should be fairly central with their mating gears when assembled.

Worm Shaft Bearings

These are in the form of small angle brackets, each being drilled to form the pivot bearing, a single securing-screw and a dowel pin for ensuring positive location. The distance of the pivot bearing from the base was arranged to give correct meshing of the skew gear with that on the motor shaft, but adjustment in this respect is possible by shimming up either the feet of the motor or the brackets, as may be required. Afterwards, the endwise location of the worm wheel on its arbor may have to be adjusted slightly so that the worm beds down centrally in the throat.

To ensure correct meshing of worm and wheel, the brackets may be temporarily clamped in place and adjusted so that the worm turns freely but with only just perceptible play in the teeth of the worm wheel. Their position can then be marked with a sharp scriber, and the hole drilled and tapped for the fixing screws; the latter are then inserted, the brackets aligned so that the shaft runs freely, and the holes for the locating dowels drilled from the backplate. The dowels are made from $\frac{1}{16}$-in. brass or steel, slightly tapered so that they fit tightly in the brackets, but only a good push fit in the backplate.

If end play is present in the worm shaft, it tends to cause noise, as the load on the pin barrel varies, and I found it desirable to fit thrust plates to the brackets, made from short pieces of spring-steel, hardened, and secured to the outside of the brackets by a single screw in each case. This effectively eliminated all but a mere suspicion of end play.

Contact-breaker Cam

This was made from a disc of Paxolin (ebonite, vulcanised fibre or bakelite would do equally well), machined to fit the boss of the worm wheel and secured to it by a grub-screw. Before machining the outside diameter, a $\frac{1}{4}$ in. hole was drilled exactly on the line of the edge so as to form a break in the surface when it was turned down. The sharp corners of the break were carefully rounded off, and the contour of the cam polished. After the "timing" of the cam has been adjusted, the point of the grub-screw can be sunk into the boss of the wheel so as to provide positive location, but this should not be done at the present stage.

It is not absolutely essential to use insulating material for the cam, but it is very suitable, being durable and self-lubricating, so that it helps to reduce friction. If a metal cam is used, care must be taken to see that both contact blades are insulated from the frame, so that the possibility of a short circuit is avoided. Alternatively, a fibre pad may be attached to the wiper blade, which will also serve the dual purpose of an anti-friction device and an insulator.

(To be concluded)

"AEROLITE" WOOD GLUE

AERO RESEARCH LTD. have informed us that they are now putting out "Aerolite" 306 in the form of a standard pack which is obtainable throughout the country from ironmongers, builders' merchants, hobby shops, etc. Each pack contains enough adhesive and hardener to cover an area of 20 sq. ft., and the retail price is 6s. 0d.

"Aerolite" 306 powder resin conforms fully to British Standard Specification 1204/B.70. It is resistant to water and heat and immune to attack by moulds and fungi; therefore, it is suitable for use both outdoors and indoors. The dry powder has a storage life of two years, and the life of the hardener is even longer.

This adhesive is used exclusively by the R.A.F. for all repairs to wooden aircraft. The only preparation required before "Aerolite" 306 is used is that a little water should be added to the powder and this mixture stored until the liquid has a thick syrupy consistency. This liquid resin is applied to one surface to be bonded, and the hardener applied to the other surface. Setting begins as soon as the two are brought together and, at normal room temperature, is complete in three hours. With this glue, heat has the effect of decreasing setting times; at 190 deg. F. the glue will set in $2\frac{1}{2}$ minutes.

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

CALENDAR CLOCKS

DEAR SIR,—May I add support to Mr. J. H. Hiscocks's letter in the February 26th issue ?

Both myself and a friend would be most interested in further articles on this subject.

Apart from those who would like to attempt a replica of this clock, they are of the greatest value to all who like to pursue their hobby a little off the beaten track. The late Dr. Bradbury Winter was a master of the art of mechanical contrivance, and many of his ingenious devices, if not the actual solution, contain the inspiration to solve problems.

His first description of the Congreve clock in 1945 gave me the urge to build a clock, which is now complete with tilting table, synchronising gear, perpetual calendar and moon train.

Incidentally, the accompanying much enlarged sketch may be of interest to readers who have built versions of this clock. I did not like the idea of having to clean the ball frequently to keep it running, and since making this modification the table has never failed to tilt.

The contact spring (1), is a piece of 0.002 in. thick steel tape $1\frac{1}{8}$ in. in length fastened in base of groove by a screw (2), and clamping plate (3). This plate (3) is 1/32 in. thick and of the same metal as the table. (In my case dural.)

Another strip of the same metal (4) is fastened on to the free end of the spring so that it just clears end of clamping plate. The spring should be set so that its free end rests under top of block (*B*) (shown in section) when not being depressed by ball. On the underside of spring (1) is soldered a small flat piece of platinum (5).

No. (6) is a piece of $\frac{3}{16}$ in. round brass with a hole tapped 8-B.A. through its centre for a platinum-tipped contact-screw.

It is wrapped with one thickness of Empire tape and set in a hole in base-plate with a spot of " Durafix."

Its length is $\frac{1}{16}$ in. more than thickness of base-plate and to it is soldered the insulated lead to release solenoid.

Screw up contact-screw until it " makes," unscrew half a turn and set with a touch of " Durafix " on underside.

(*A*) in the sketch is a separate view of contact spring in an exaggerated depressed position.

Finally, may I offer a tip re fly-cutting. Try a small fly wheel on the spindle, it is a great improvement.

Anyone making the one recently described by Mr. J. C. Stevens would have to make the spindle and frame longer so that the fly wheel would clear the blank being cut.

Yours faithfully,

Mansfield. H. R. GRIFFIN.

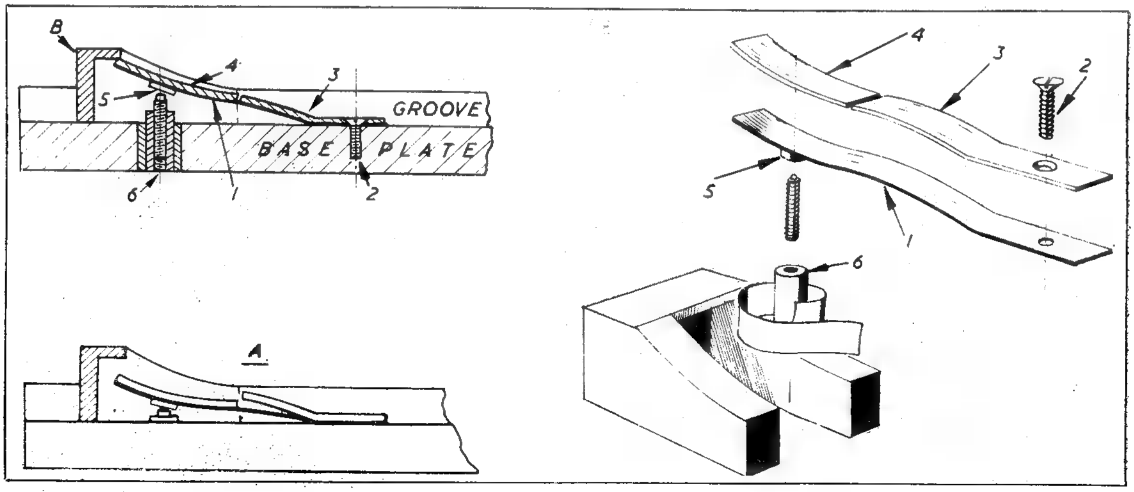
HOME CASTING PROBLEMS

DEAR SIR,—Referring to Mr. Terry Aspin's article dealing with the high pressure spray-gun, in THE MODEL ENGINEER, January, 22nd issue, I should like to offer a suggestion with regard to the casting of the gun body. Mr. Aspin suggests that the nose be made egg-shaped on the pattern, in order to get a deeper impression in the sand, with the idea of making allowance for contraction when the metal is cooling. It would also appear that unless this is done, the circular parts of the casting will be flat on the cope side. I agree, this does happen sometimes, but in this particular case I've found the solution to the problem, as follows :—

As soon as possible after the mould is full, insert a feeder-rod ($\frac{5}{16}$ in. diameter mild-steel previously heated) into the runner, and move up and down in a regular manner, until the metal begins to stick to the rod, then remove, care being taken not to touch the sand. I have made three castings of the body of this gun, and every one is perfect, and circular where it applies, using this method. I should like to thank Mr. Aspin for what I hope will turn out to be a very welcome tool to add to my rather meagre workshop equipment.

Yours faithfully,

Sidcup. NORMAN F. HODGES.



"POCKET" WORKSHOPS

By Terry Aspin

THERE must be thousands of model engineers who, through the limit imposed by either resources or accommodation—or both—have access only to one of the smallest and most humble of lathes. It is upon one of these (the Super Adept) that these notes are based. One which began its useful life in the days when finances available for its purchase would never have stretched to the sum, say, of seven pounds, for which one could have acquired at that time (long bed model 10s. extra !) a 3 in., gap bed, back geared, screwcutting lathe, 12 in. between centres with fully compound slide-rest, set of change wheels and usual accessories.

By comparison the Adept was 36s. 9d., and thus it came to be bought.

It was not, however, until 1946 that it started work in earnest, but from then until May, 1949, when work again, and for the next couple of years it went into well-merited retirement. I even contemplated selling it. But it was to see the dawn of a new day, because, for my workshop, I have to utilise a portion of the garage and this, of timber and asbestos construction, in winter becomes unbearably cold. Thus in the past I have been forced to curtail my model engineering activities to nil while the temperature was low, and I began to appreciate the value of a small, compact lathe with countershaft and motor, which could be carried indoors and used in a more hospitable climate.

Rewinding the Motor

In that way the plan took shape last year of putting the Adept in working order again, and to this end I purchased a small induction motor, originally wound for 50 volts, 3 phase and rated at 1/40 h.p. 3,000 r.p.m. at 50 cycles. Each pole was occupied by three overlapping coils of ninety turns, which detail afforded me something upon which I could base my calculations of the new windings.

In this matter I must confess that all the credit is due to a certain "Percival Marshall" publication entitled *Small Alternating Current Motors* by Alfred H. Avery. For the amateur interested practically in the subject of small induction motors, I unreservedly recommend this book. The necessary data are laid out in a simple and straightforward manner.

For my purpose, I decided to retain the motor as a two-pole machine to give the same high speed. With the initial power so limited, it seemed that high speed and great reduction would provide the best results. Thus I arrived at the conclusion that a new winding of six coils, 420 turns per coil of 31-s.w.g. enamelled wire would give a torque comparable with the original. In fact, according to my calculations (though I am no Einstein) it showed an improvement of about 240 ampere turns !

For this job, as it was obviously

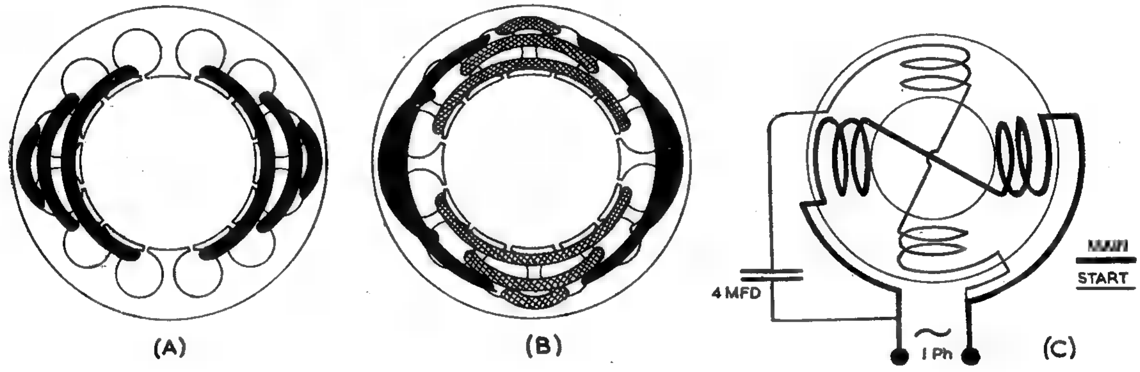


Fig. 1. "*A*"—*position of run windings* ; "*B*"—*start windings* (*hatched*) *overlaid at right-angles* ; "*C*"—*wiring diagram*

it was finally supplanted by a prouder sister of $3\frac{1}{2}$ in. capacity, it constructed, quite unaided by any other machine tool, one horizontal steam engine and three internal-combustion engines from 3 to 5 c.c. Two of the latter were two-strokes and one an o.h.v., one from a set of castings and the remainder hacked from the solid !

The claim is not that these models were superb—on the contrary—but that when no other tool is available the truly modest machine can be persuaded to do the work.

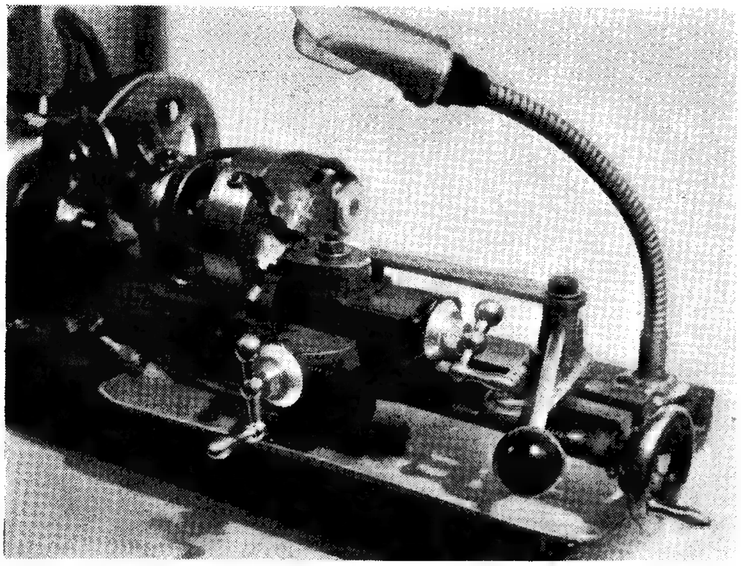
The Adept was never expected to

It was claimed by the people who offered it for sale that this motor would run off the 230-volt mains if connected, according to their diagram, in series with a resistor and condensers which they supplied. This proved by no means satisfactory in my estimation, so I decided to rewind the motor completely and attempt to run it directly from the mains as a split-phase start.

On dismantling I found I had a machine whose stator carried twelve slots divided into two poles, which would give a speed of approaching

impossible to place the wire in the slots one at a time, I employed a home-made coil winding machine (very crudely thrown together) on which could be mounted as required three simple plywood formers. As far as possible to avoid mistakes a counter salvaged from a scrapped electricity meter was arranged to be driven by the tail-end of the spindle carrying the formers and, let it be placed on record, the counting at least proceeded without a hitch !

The next operation was to insert the wound coils into the insulated



Adept (No. 1) showing hand stroking device

slots, and to accomplish this the turns had to be separated and eased in a few at a time, a very ticklish operation which caused involuntary beads of perspiration to form on the forehead many times before it was completed.

The running windings were connected in series as shown in the diagram (Fig. 1) and then came the turn of the start coils. A reference to Mr. Avery's little book indicated that these could, for practical purposes, be composed of the same number of coils as the main windings but disposed to them at an angle of 90 deg. (electrically). This proves to be a geometrical 90 deg. also when applied to a two-pole machine such as this and each coil must have only about half the number of turns of wire, and these about six gauges smaller. I actually used enamelled wire of 38-s.w.g. which I wound on the same set of formers.

Once again came the work of feeding the wire into the slots, now already partly occupied by the first coils. Here, I think that reference to the task should be quite brief as, I am sure, every model engineer will be equally well acquainted with the phenomenon of fanatically attempting some job which is apparently impossible, and finally by dogged determination bordering on madness, to bring it to a satisfactory conclusion. Here was indeed a case in point, so that, eventually, and in spite of all, I found myself plugging my motor into the mains supply and anticipating the blue flash which surely must follow.

Instead, however, the motor commenced to revolve. But not, perhaps, with quite the lively torque for which I had hoped. Soon, with the rapidly heating-up of the start coils, it became abundantly clear that, for running at least, something would have to be interposed between them and the direct supply.

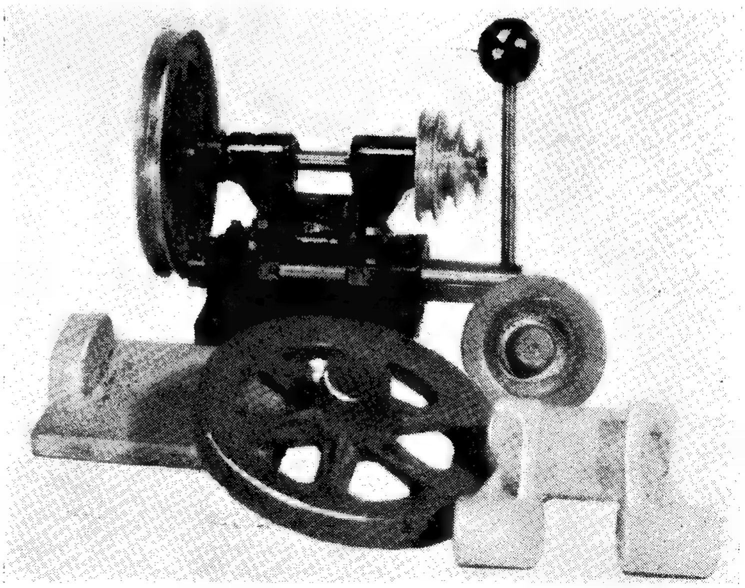
At that time I was toying with the idea of providing a manual or perhaps even an automatic switch for cutting out the start winding when once the rotor had run up to speed. Instead, events proved that the answer to the problem was already to hand in the form of the condensers supplied, as mentioned above, with the motor when it was purchased. There were four of them of 2 MFD capacity each and I found that, by their aid, the torque could be increased quite up to my expectations and the temperature kept within bounds. Ultimately, for the best results as "capacitor run," I settled on two of the condensers in parallel to give a total of 4 MFD, they in turn connected in series with the start coils and the mains.

This arrangement produced a compromise between not, perhaps, the greatest starting torque but quite the coolest running. For safety, of course, the body of the motor is earthed.

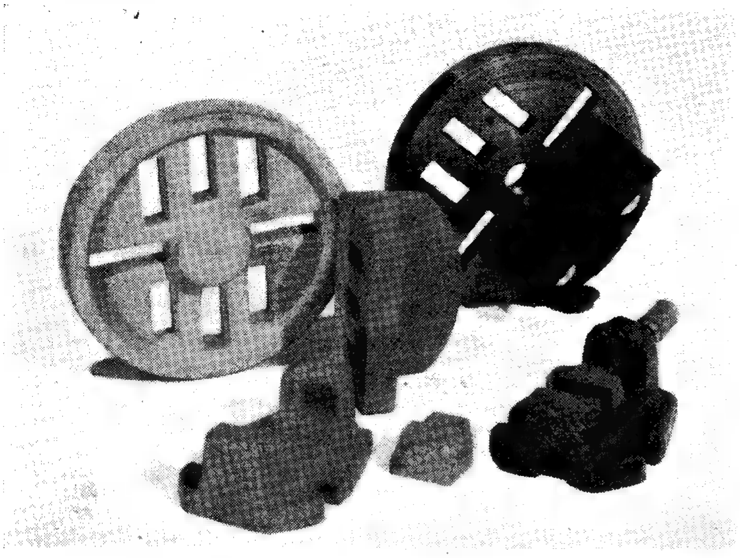
The motor spindle carries a V-pulley whose outer diameter is 1 in. In spite of the limited power, a satisfactory drive is transmitted by means of a Singer sewing machine V-belt to the 4½-in. wheel of the countershaft. Another belt of the same kind completes the final drive to the lathe.

The Countershaft

Countershaft patterns, made originally for use with a hacksaw machine,



Countershaft with patterns



Faceplate, angle-plate and vice with patterns

were pressed into service again and aluminium alloy castings produced in my "foundry." No modifications to the original patterns were necessary, but two new pulley patterns were required. A spoked pulley $4\frac{1}{2}$ in. in diameter was jig-sawed out of a solid piece of packing-case timber and finally produced a very pretty wheel. The other was the pattern for the cone pulley, and two castings were poured from this: one for the countershaft and the other to replace the original cast-iron one fitted to the lathe mandrel. A new pulley was needed here, because the groove in the Adept pulley, provided to take round leather belting, proved to be cut at the wrong angle for the Singer belts I was proposing to use.

The countershaft is simple enough in design and relies for its action on the cam principle which is, in reality, two flats milled (or filed) on the actuating spindle engaging with the rounded heads of two lock-nutted, adjusting screws of $\frac{3}{16}$ in. B.S.F.

No originalty is claimed for the design but it has, in fact, one great virtue from the point of view of the mechanic with less than modest equipment. At a pinch it could be "machined" entirely by means of a hand brace and a $\frac{3}{8}$-in. drill! The possessor of a bench drill could waltz away with it.

I have used the aluminium alloy unbushed and this has proved satisfactory in practice. No doubt better workmen would use better methods but, many and varied as may have been the white elephants produced in my workshop, this little mechanism, at least, has proved a complete success.

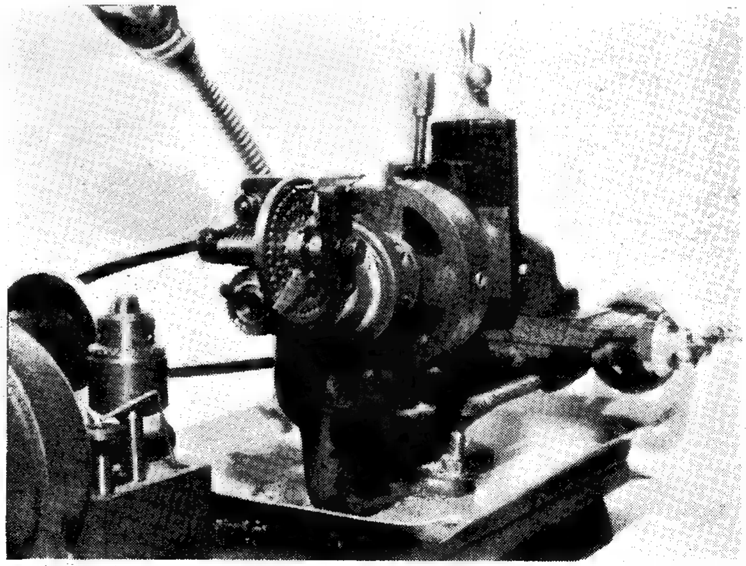
Lathe Modifications

One of the first jobs to be done on the lathe itself was the re-boring of the headstock bearing, and I decided to increase it from $\frac{3}{8}$ in. to $\frac{1}{2}$ in., mainly because I wanted to bore it through $\frac{1}{4}$ in. clear. But although this has been accomplished quite satisfactorily on my lathe, I would not generally recommend so drastic an increase. I now believe that to have enlarged the bearing $\frac{1}{16}$ in. over its original size would have proved quite adequate, and this I would suggest to others with a mind to follow suit.

The actual boring took place on the larger lathe already referred to, using the Adept's own tailstock, with barrel removed, as a guide to the boring bar. This resulted in the new bore being quite true with the centre of the tailstock—a condition not by any means proved on the original lathe.

A new headstock spindle was produced from a piece of $\frac{3}{4}$-in. mild-steel bar. This was machined $\frac{3}{4}$ in. longer to project behind the rear bearing; I had visions at the time of utilising this extra length for fitting, perhaps, a driving pinion for a train of screw-cutting gears; and the nose was threaded half inch B.S.F. and provided with an orthodox chuck-register.

Using a hollow mandrel like this rendered the centres supplied with the lathe useless, and in any case they were considered inadequate. At the same time new centres promised to be smaller than any standard taper known to me. So to produce them I set over the top-slide of the $3\frac{1}{2}$-in. lathe with the aid of a dial indicator, to correspond



A view of the dividing attachment (No. 1)

to No. 2 Morse taper and turned up a complete set of miniature centres together with a piece of silver-steel tapered to match. From the latter, of course, a "D" shaped reamer was made for the purpose of forming the sockets.

The new centres are 1½ in. in length compared with the 1 in. of the original and I was able to machine at one setting a nice, comprehensive selection; all the usual varieties and some useful additions of my own.

Here I would like to describe my method of finishing turned parts to a reasonably high degree of accuracy and a particularly good appearance. To begin with I must confess, in my own opinion, to being only a second-rate turner, so I usually take the last fine cut leaving about a thou. of excess metal, and this I bring down to final limits using a flat carborundum hone with oil; making nice, even strokes against the rotation of the work at high speed. Tool marks are first removed with a medium grade of stone, checking frequently with a micrometer. A fine grade stone is then applied and I am usually satisfied if the final reading shows a measurement of within half a thou. plus of the size required. If greater accuracy is required, even this margin can be erased with care and, when fitting centres to my 3½ in. lathe I find that to finish them by grinding in this way allows them to drop home with a most satisfying "plop"!

The tailstock barrel was the next item to receive my attention and a new one was made with no alteration in dimensions except with regard to fit, which was improved, and, of course, the socket, which was made to correspond to the new centres.

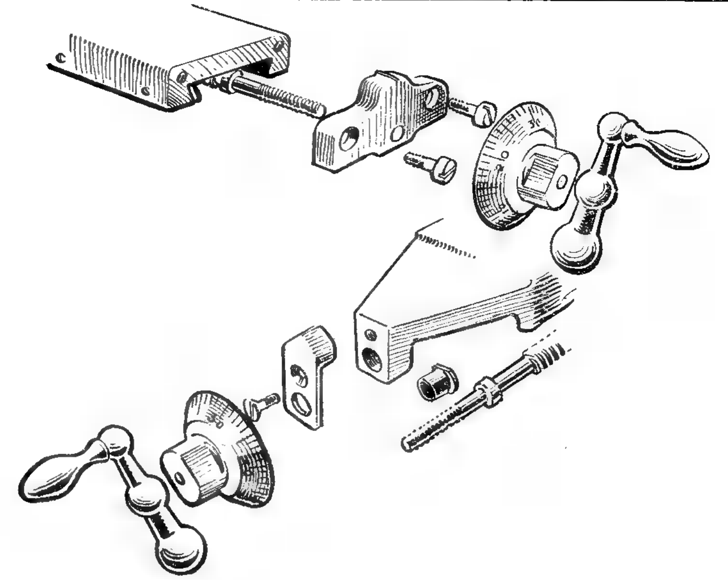


Fig. 2. Exploded sketch of top-slide and cross-slide indices

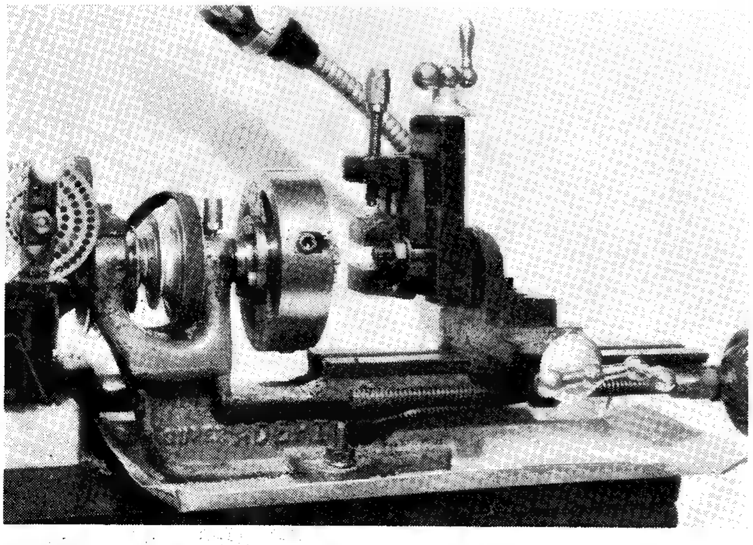
The original handwheels fitted to this lathe were, to my mind, "poor little cripples" and were most certainly too small to allow of a steady feed using the handles. So a pattern was made in wood and the "foundry" pressed into service again to produce two little iron wheels; one to be bored plain to fit the lead-screw and the other screwed internally, 10 t.p.i. acme to fit the tailstock. The result of this operation can be seen in the photographs and can it be argued that an improvement has not been effected in appearance also?

Next to receive attention was the compound slide-rest and again the photographs will show that ball handles have been provided in place of the little cast knobs, and micrometer indices added. All of a familiar pattern, no doubt!

The actuating screws were formerly ¼ in. Whitworth but, with the object of making the working smoother, new screws were cut with tiny square threads having 20 t.p.i., and a suitable tap was produced from silver-steel at the same time for re-cutting the nuts to match. With this pitch the indices have fifty divisions, each representing one h ousandth of an inch.

The actual casting of the cross-slide remains unaltered, but not so the top-slide. Here it was considered that the tapered portion was superfluous and that the greater length afforded by it left too little room for the fingers if it was to be manipulated with comfort. So that part was sawn off close to the gibs and a new thrust block, complete with pointer, affixed by means of two 4-B.A. screws (Fig. 2).

(*To be concluded*)



Showing how the vice can be set up on the top-slide and angle-plate for simple milling

The Allchin "M.E." Traction Engine to 1½ in. Scale

by W. J. HUGHES

AS I promised last time, a photograph of Trevor Whitaker's tools for splining and broaching is reproduced herewith.

Originally, Mr. Whitaker intended to use a fly-cutter to mill the splines, but found that his vertical-slide was not stiff enough to "stand the racket." He therefore used the same cutter, in the toolpost, to turn a mild-steel disc. From this a section was cut (in the foreground in photograph), case-hardened, and used as a form cutter to make the blank for the milling-cutter, also from mild-steel.

The teeth of the cutter were then formed with an angle milling cutter, and case-hardened after being backed off. The result is seen at left of the photograph, and it did the job perfectly.

Instead of making a single broaching tool, Mr. Whitaker made the three "drifts" shown, each having the teeth progressively larger in diameter. The teeth were backed off slightly, and the drifts case-hardened.

The gear-centre in his case was turned from manganese bronze, and the drifts were forced through the bore successively, using the vice-jaws to supply the pressure. The procedure was to insert the drift into the bore, squeeze it in about $\frac{1}{16}$ in., remove it to clear the chips away, force it in another $\frac{1}{16}$ in., clear the chips, and so on. He says that the fit of the gear-centre on the shaft is quite good, with only the very slightest shake.

Thanks, Trevor, for your information.

Continued from page 362, *March* 19, 1953.

Gearing and Driving Arrangements

The Allchin that we are modelling is a four-shaft engine of course, although the makers also built three-shaft ones, so that customers could take their choice. The difference between the two systems has already been described in "Talking About Steam. . . ." and in my book, so need not be entered into here.

I have already published, in the Allchin serial, a photograph of the change-speed gears (August 7th, 1952), and this picture may well be looked up by the reader now. The fork marked *F*, which we have already made, fits into a groove in the boss or centre of the change-speed wheels to enable the slow or fast speed spur-wheel to be engaged at will. In the position shown, the motion is in neutral, of course, so that the engine itself would be running free.

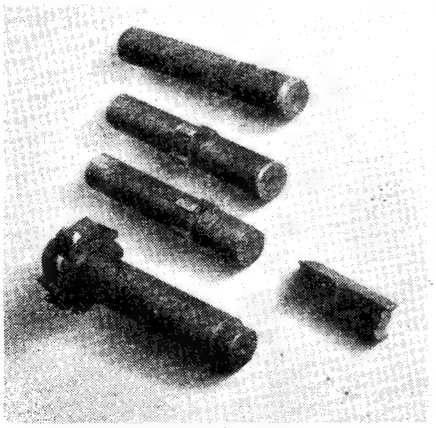
A word of warning about the general arrangement drawings reproduced is desirable. Some slight alterations in *detail* have been made since these were prepared, but the arrangement of the parts is substantially the same.

On the right-hand end of the second shaft is a pinion, engaging a spur-wheel (behind which the brake drum is positioned) on the end of the third shaft. The other end of the latter carries a pinion which in turn drives the large spur-ring mounted on the compensating-centre.

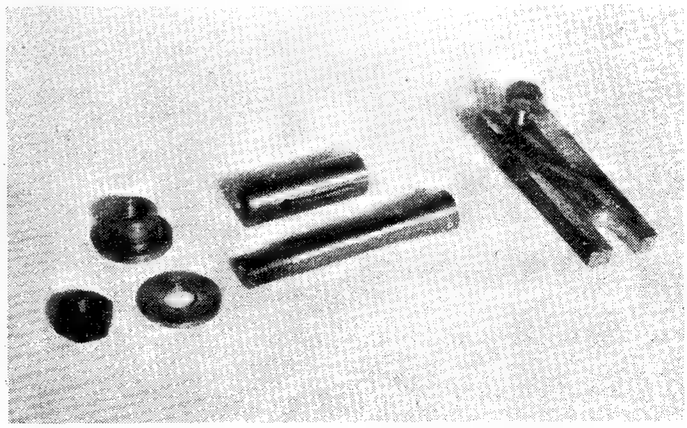
The centre itself carries the three bevel pinions of the compensating gear; the right-hand bevel wheel is keyed to the hind axle, and the left-hand one can run free on the axle. The bosses of both are extended inwards, and the compensating centre runs on these bosses. (Actually, in travelling on a straight road, the centre and the bosses naturally rotate all at the same speeds, and together; it is only when the hind wheels are rotating at different speeds, in turning a corner, that any movement takes place between them.)

The hub of the left hand hind wheel (not shown) is a running fit on the axle, being driven by two pins passed through the lobes of the hub into the left-hand bevel wheel. When it is desired to lock the compensating-gear, so as to give a "solid" drive to both hind wheels, one of these pins is removed, and replaced by a longer one which penetrates into a hole in the compensating-centre.

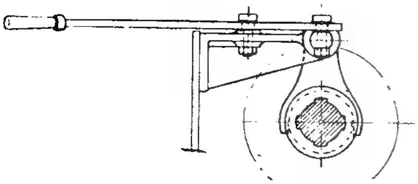
On the right-hand end of the axle, a driving boss is keyed. The wheel is again a running fit on the



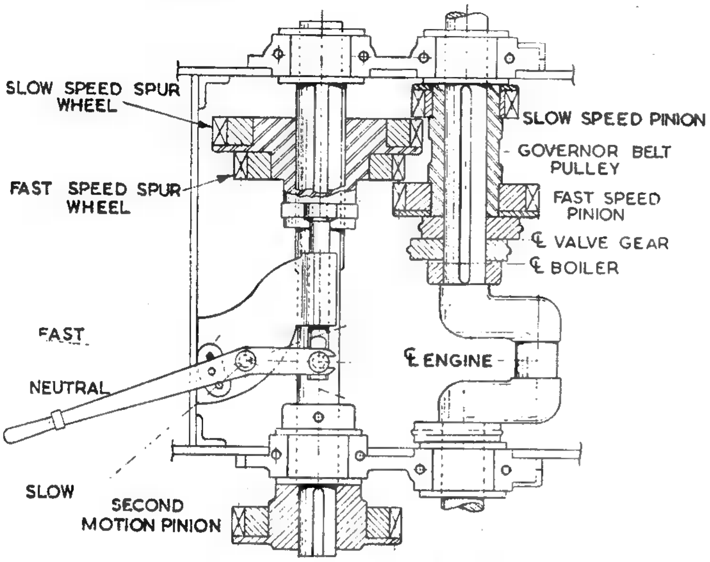
Photograph No. 29. Tools used by Trevor Whitaker, as described in the text



Photograph No. 30. Parts of the dividing attachment for mandre mounting



ELEVATION OF GEAR CHANGE ARRANGEMENT



General arrangement of the change-speed arrangements

axle, and the connection between the two is by two pins as before. In this case, however, the pins are a fixture, and do *not* pass right through to the outside of the lobes.

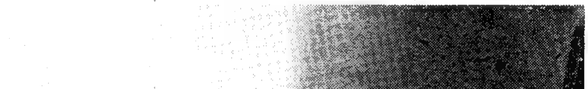
By the by, a correspondent a while ago, pulling my nether limb in good-natured fashion, asked why I kept on using "archaic" terms, like "hind-wheel" and "compensating gear" and "boiler front," instead of the modern terms "back" wheel, "differential gear," and "backhead." My answer was, and is, that we are not dealing with a really modern subject, so let us stick to the terms which were in common usage by the men who used to work and love these machines! Nothing wrong with a bit of sentiment even in this modern world, is there?

No Instructions for Cutting Gears

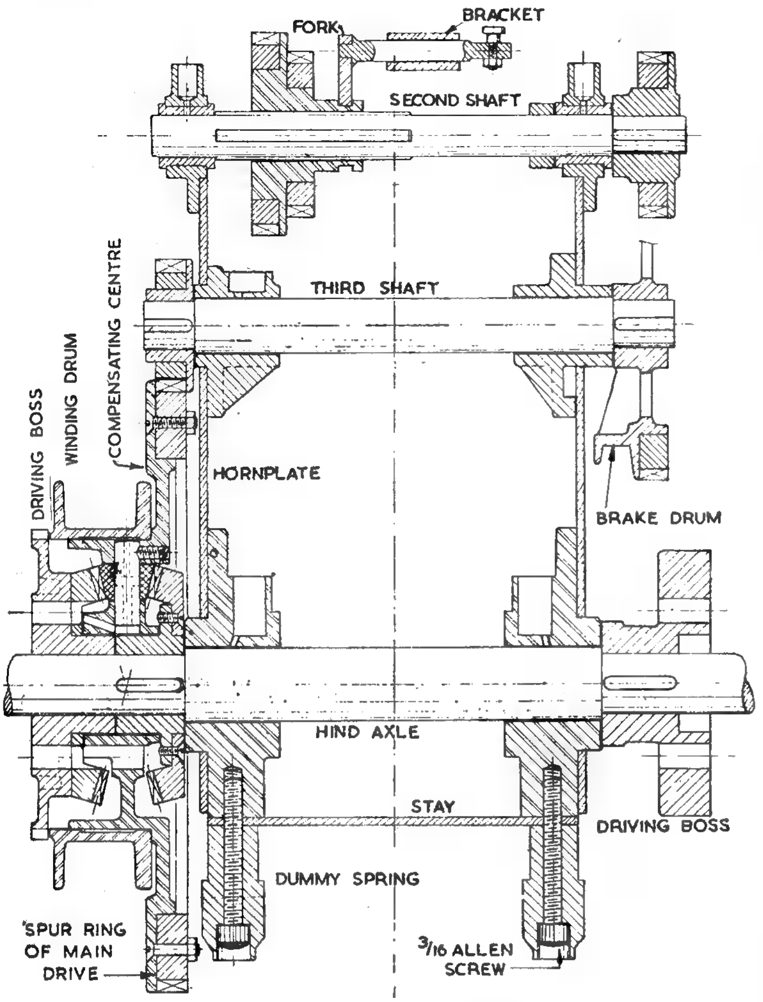
One point on which I want to be clear from the start is that I do not propose to give instructions for cutting the various gears. Many readers will, no doubt, wish to cut their own, but there have been plenty of articles on the subject in these pages, and it would be superfluous to repeat them for the Allchin. We've enough to do as it is!

However, for the builder who has not the inclination, or perhaps the

Photograph No. 31. Method of using the attachment. The end of the detent screw is turned to a 60 deg. taper



Photograph No. 32. Ready to commence slotting. Note chalk mark on tool to indicate depth



General arrangement of gearing. For the sake of clearness, shafts are shown as though arranged vertically above each other, though not, in fact, actually so

tackle, to cut his own gears, I have arranged with Bro. Reeves to do the necessary, and the samples he has sent for inspection are very good. At the time of writing, the bevel pinions and wheels are not available, but they should not be long now.

All the spur-wheels and pinions in the prototype are shrouded, and are cast in steel. In the large size, of course, the very slight irregularities due to the casting could be dealt with easily, but in our case, they would assume comparatively vast proportions, and cleaning up would be virtually impossible, because of the shrouding. It is necessary, therefore, to use separate gears, pressed on to suitable centres. With care, it will not be possible to tell the difference.

Centre for Change-Speed Spur-Wheels

The centre for the change-speed spur-wheels as supplied by Reeves is an iron casting. Grip the smaller boss in the three-jaw chuck, and clean up the boss for the larger wheel, but *do not* go down to size. The only object of this operation is to give true surfaces to afford maximum grip to the chuck jaws when slotting out the four grooves or keyways in the bore. Reverse the casting in the chuck, and again rough turn the outside surfaces. This time you can leave just a few thous. on all dimensions for the later finish-turning with a keen tool, but do not cut the groove for the change-speed fork. Just a reminder for turning cast-iron; use back-gear (belt on the middle pulley for this size), and see that the tool gets well under the skin in the initial cut.

Centre the end of the boss, using a centre-drill in the tailstock drill-chuck, and drill right through with successively larger drills up to $\frac{3}{8}$ in. diameter. However, since the bore must be dead true with the outside, it must be finished to size with a boring tool held in the toolpost. Take time over this operation, and guard against a "bell-mouthed" bore by traversing the tool frequently without putting any cut on; this allows the spring of the tool to be taken up. Because of the small diameter, a faster mandrel speed may be used in the drilling and boring, of course. The bore should be a good running fit on the $\frac{7}{16}$ in. diameter of the second shaft.

A Dividing Attachment for the Mandrel

With the resources at our disposal, it will not be possible to broach out the four keyways at one pass, as would be done commercially. I have already described Trevor Whitaker's method of forming them with his three drifts, but it is doubtful if this method will save any time *in the long run* over my method. It may perhaps, if you have to make up the dividing fitting for the lathe mandrel, but the latter will be so useful in many ways in your workshop activities that it is well worth making anyway, unless you have other methods of dividing in the lathe.

Photograph No. 30 shows the component parts of the fitting, and the drawing the arrangement. The dimensions given are of my own, made to fit the Myford ML7, and may need some variation to suit other readers. It will be seen that the attachment simply plugs into the outer end of the mandrel. The change wheel is mounted on a centre or collar fitting on the draw-bolt, and when the nut is tightened, not only is the split sleeve tightened in the bore of the mandrel, but the wheel is simultaneously clamped between the washer and the shoulder of the centre, making it virtually solid with the mandrel. Detailed instructions are not necessary for the making, I think, except to point out that the taper in the bore of the sleeve and that on the draw-bolt should match, and that the thread to the latter should be screwcut. The bracket holding the screw was made from 1-in. × $\frac{1}{4}$-in. bar; brass in my case, but could be steel. It clamps under the lubricator. Needless to say, and *very important*;

the dividing attachment must be made *before* starting on the wheel-centre !

Planing the Keyways

Now, to get back to the latter, it will be necessary to plane away most of the waste from the keyways, and so to leave a minimum of work for the broach to do.

" Duplex " recently described the operation, including the tools for the job, but where the bore is small, I prefer to use a tool with an inserted bit, as shown in Photographs Nos. 32 and 33. The bar is, in this case, $\frac{3}{8}$ in. diameter silver-steel, with a cutter filed up from 5/32 in. diameter silver-steel to the shape shown. It fits into a hole drilled cross-wise in the bar, and is held by a 4-B.A. Allen grub-screw tapped into the end. Incidentally, the bar can also be used, with a different cutter, as a boring bar.

When filing up the tool-bit, the dimension at (*a*) should be two or three thous. less than the width of the splines on the shaft. The bit is hardened right out, and tempered to light straw colour. If it projects at all through the back of the tool-bar, grind off the surplus.

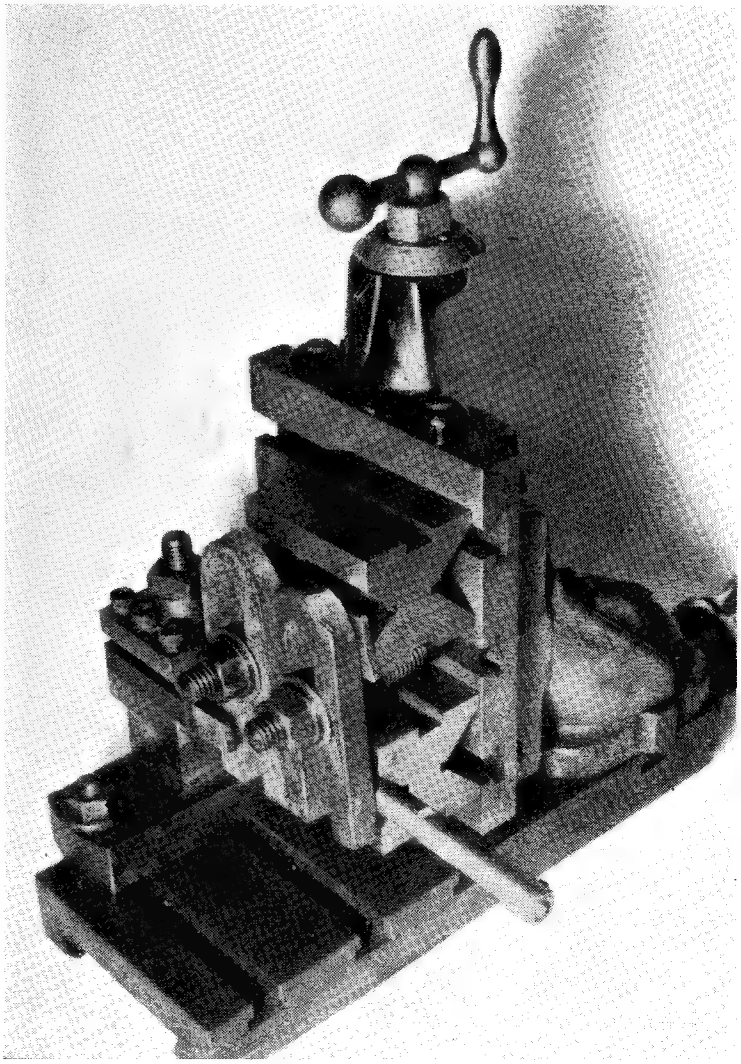
The photographs show my method of holding the tool; use of the vertical slide means that it is easy to set the tool to correct height without bothering with packing. The upper vee-block has no significance; it is merely being used as packing under the clamps. (These are a favourite type of mine, simply forged from $\frac{3}{8}$-in. square section mild-steel bar.) Similarly, the only reason for the presence of the back toolpost is because it formed a readily available stop for the end of the planing tool to butt up against.

Plug the dividing attachment into the mandrel, with the forty-tooth change wheel on it. Chalk the latter at every tenth tooth, and engage the detent screw with one of these divisions.

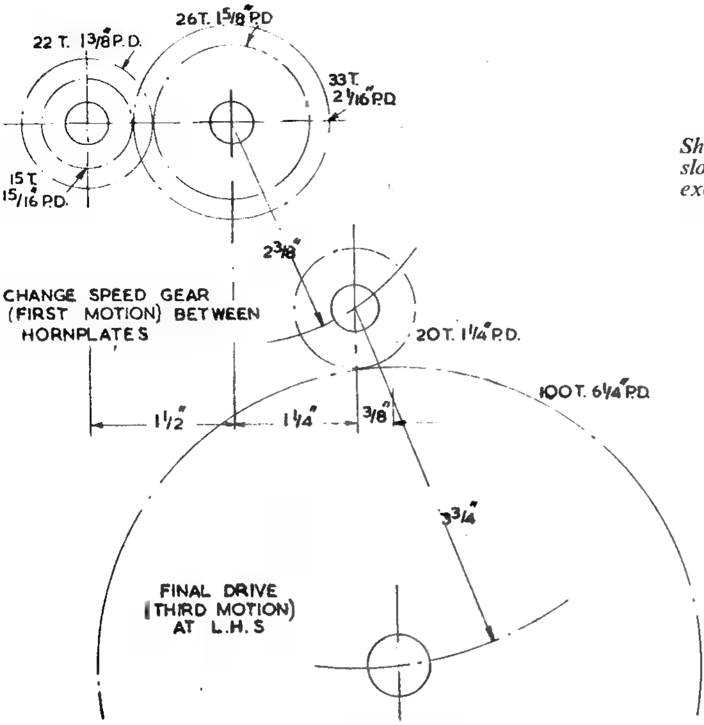
Set the tool-bit so that its centre is at lathe centre-height—test with the surface-gauge—and see that the bar is parallel with the axis of the lathe, both ways.

The slotting is done by racking the saddle forwards and backwards, as in making the milling-cutter last time. Tip: if your hand tends to get sore when doing this, slip the bowl of an old tobacco-pipe (stem downwards) over the handle of the racking hand-wheel, curl the fingers and thumb round the bowl and part of the stem, and let the inside of the bowl take the friction as you turn the handle ! Don't advance the tool more than two thous. at a time, and take at least two cuts on each position. Finish off by several cuts on the last reading, until you hear that the tool has stopped cutting; note the reading. When one groove is cut, slacken the detent screw, turn the mandrel through 90 deg., and lock it again with the screw. Cut the second groove in the same way, to the same depth, and repeat for the third and fourth ones.

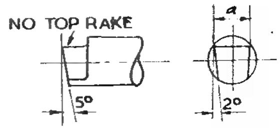
The turning of the work may next be completed, using a keen knife-tool very slightly rounded on the tip. Turn the groove with a narrow parting-tool, making two cuts side-by-side to the same depth. The exact diameter of the boss marked as 1 in. is, of course, dependent on the internal bore of the fast-speed pinion. Measure this with the internal calipers, very delicately, and " mike " the calipers, also very delicately. (The spring variety are best for this job.) Then turn the boss not less than one thou., and not more than two thous., *larger* than the measurement. Alternatively, when getting near to size, turn the outer 1/32 in. or so of the boss until it will just, and *only* just, enter the bore of the wheel. Note the reading of the micrometer collar, and take the final cut at from half to one thou. *less*, making the diameter from one to two thous. more. This method can be used



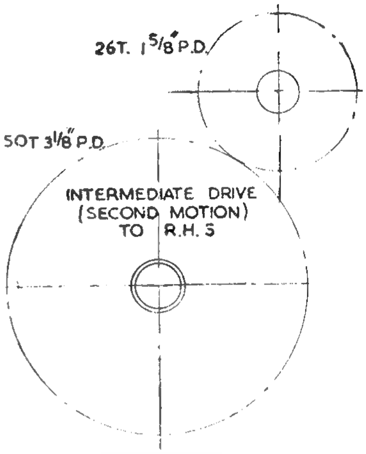
Photograph No. 33. *One method of mounting the slotting-tool. The parting-tool has nothing to do with the operation* !



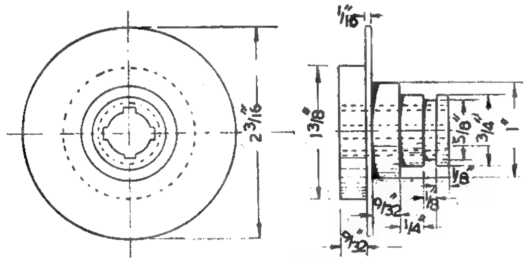
Centres and dimensions of gears of first and third motions



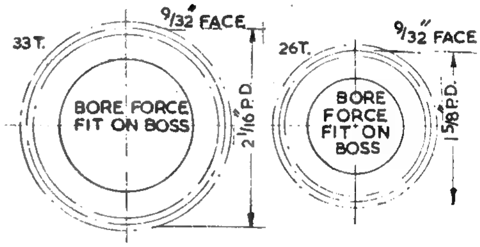
Shape of the inserted cutter-bit, for slotting cast-iron. For other metals, except brass, slight top rake desirable



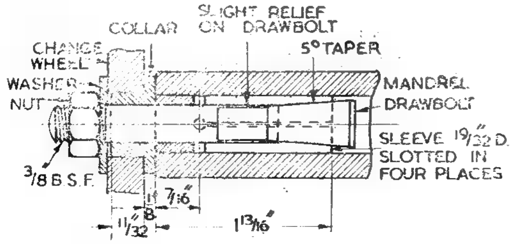
Centres and dimensions of gears of second motion



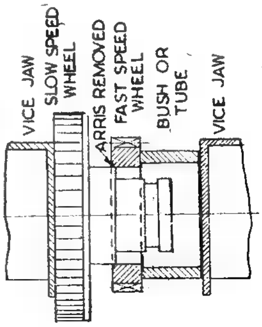
Mounting centre for change-speed spur-wheels



Slow and fast speed spur-wheels



Arrangement of a dividing attachment which will be useful on future occasions



How to press home the fast speed spur-wheel

with the larger gear wheels, incidentally, where, unless you have larger mikes than one-inch, you will not be able to use the other method, anyway.

The other boss, for the slow-speed spur-wheel, naturally must be concentric with the bore also, and probably the best way to machine it is to run the work on a mandrel, between centres. Alternatively, it may be set up in the four-jaw chuck, gripping the other boss, so that the rim of the shroud runs true. Turn it to be a force-fit for the bore of the wheel by the second method outlined above, or by the first if you have a two-inch mike.

Before pressing the wheels home, remove the sharp arris or corner on the inside of the bore so that it will not interfere with the true seating. This may be done with file or scraper. The slow-speed wheel may be pressed home first, between the jaws of the vice, and with the vice clamps in position. It should fit tightly up to the shroud, with no gap at all.

The fast speed wheel may now be seated, using a bush or a piece of tube of at least 1-in. bore and $\frac{5}{16}$ in. width between it and the vice-jaw, as in the sketch. What was that? You're afraid yours isn't as tight as it ought to be? Well, there's no need to throw the thing in the scrap-box!

If it's a *good* fit, drill a 7/64-in. hole $\frac{1}{4}$ in. deep on the junction of the two parts; that is, half in the boss and half in the wheel. Follow up with a $\frac{1}{8}$-in. drill, which should leave the hole dead size. Drive in a stub of $\frac{1}{8}$-in. silver-steel, and there you are.

If there is any shake at all, however, between the two components, turn the boss down to $\frac{1}{8}$-in. less, and make a steel bush to press on it. When this has been forced on, turn it down to fit the bore of the wheel, and don't make any error *this* time. All this should be done, of course, with the work running truly, preferably on a mandrel.

I'd hoped, this time, to describe the broaching of this wheel-centre but there are rather more drawings and photographs than usual, so space is used up, unfortunately. But meantime, don't be tempted to take a skim off the faces of the gears: leave that until after the broaching!

In conclusion, in the last article, under the instructions for milling the splines, there is a reference to the "$\frac{7}{16}$ in. (plus 0.002 in.) diameter of the shaft." Please forget that "0.002 in."

(To be continued)

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

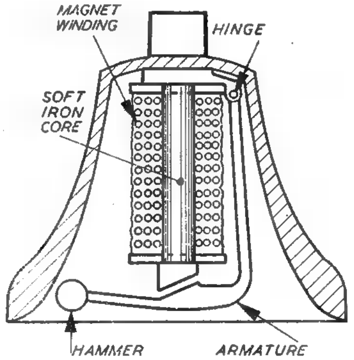
(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Bell Strike Mechanism

I have constructed an electric clock striking mechanism operating on 18 volts rectified a.c. which is required to strike on a large bell 400 lb. in weight. Could you inform me how to construct an electro-magnetic hammer to be operated from the electric contact mechanism, and capable of being fitted, preferably inside the bell, which would be reliable over a long period? I am more concerned with the principle of the device than details of dimensions.

C.E.F. (Johannesburg).

We are reproducing a drawing of a very simple electro-magnetic hammer mechanism which can be applied to a "hung" bell of any size, and will work efficiently on high



or low voltage if the windings are suitably adapted.

The mechanism is entirely inside the bell, and takes the place of the normal clapper. It embodies a central soft-iron core located in the centre of the bell where it may be attached by one or more bolts through the top. These should be as close to the centre of the bell as possible, and no part of the mechanism should touch the sides of the bell in the free position. The armature is hinged to a bobbin near the top of the core, and is so designed that when attracted to the core, the hammer makes a single stroke on the inside of the bell.

As you are mainly concerned with the principle of the mechanism, we have made no attempt to give an exact specification, but it would be a very simple matter to arrive at a satisfactory winding to suit the voltage adopted, and there is a good deal of latitude in the general proportions of the other parts.

Blower for Forge

I intend making a blower for a forge, to do brazing, and would appreciate your advice on the following points:

1. *How many blades will be needed?*
2. *What size should the blades be (length and breadth)?*
3. *Should blades be parallel or tapered?*
4. *How close should blades run to the casing at the sides, and the circumference?*
5. *Size of air inlet and outlet?*
6. *Should the blades clear the bottom of casing by about 2 in.?*

C.H. (Tottenham).

The blades should taper and have plenty of clearance between them and the casing. The following formula will be found useful :—

Length of vanes $\frac{D,}{4}$ width $\frac{D,}{4}$ diameter of inlet $\frac{D,}{2}$ eccentricity of fan $\frac{D,}{2}$ where D is the diameter of the fan. We would recommend you to use six blades; outlet should be equal to inlet diameter. The following figures should give an ample capacity: Fan wheel 8 in. diameter; outlet and inlet 4 in.; blades 2 in. by $1\frac{1}{2}$ in. at top, and 2 in. length. Actually, a 6 in. diameter wheel with corresponding sizes should prove sufficient.

Speed will vary according to air pressure required—3,000 to 5,000 r.p.m. The ideal arrangement is a small fan running at high speed, to provide a good air pressure. Clearance between fan and casing should be about $1\frac{1}{2}$ in. at tip, and 1 in. at sides.

Reamers

There are reamers with right and left-handed spiral flutes, also with straight flutes. Could you please advise me which is the best type to use?

For taking fairly deep cuts off small rods held in an s.c. chuck, would a right-hand knife tool be the most suitable? From my own experience, a tool with rather much top-rake often digs in the metal, thus forcing the rod up or the tool down. Lastly, what is the best angle of side clearance, and how much side rake is allowed with a knife tool like this?

M.B. (Bristol).

The best type of reamer for all-round work is one with left-handed spiral flutes. So far as we know, a right-handed spiral-fluted reamer is very uncommon. It would seize and break if used in a fairly deep hole.

For turning slender work, we should say the best kind of tool is a pointed one with the extreme point rounded off, and its edges set on a piece of oil stone. The top rake could be as much as 25 deg. and if side rake is added to the top, it will feed much more readily. This side rake can be similar to top rake as applied to a right-hand side cutting tool, i.e. top surface of the tool is sloped down from left to right, so that the left-hand or advance side of the pointed tool is higher. Provided this tool is really sharp and set with its point dead level with the centre, it should never dig in.

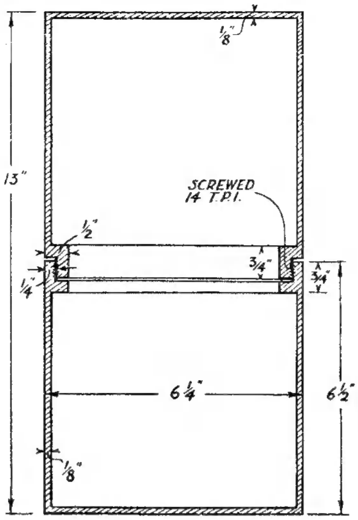
Making Boiler from Steel Cylinder

I am thinking of making a boiler from two pieces of forged steel which have been partly bored out. At present the walls are ½ in. thick, but I propose having the two pieces bored out further, and screwed together as shown in the sketch. Could you please advise me whether the screwed joint will be effective, and what pressure the boiler could be worked at?

L.S. (Brixton).

Reckoning a factor of safety of 8, a safe working pressure would be about 200 lb. per sq. in. (neglecting the screw joint). The shearing strength of the screw joint, if properly made, and allowing the same factor of safety, is above the figure given.

The joint should be nicely faced where the ends bear, and packed with thin asbestos steeped in boiled oil. As far as possible, keep the fire off the screwed joint. To guard against deterioration of the joint due to expansion and contraction, and also to strengthen the ends, put



in several $\frac{3}{16}$-in. steel stays, say one in centre and four round near the edges. The latter must be screwed up fairly tight. In boring out, make the inner corners rounded. The boiler should not be worked above 100 lb. p.s.i.

Small Petrol Engines

Please advise me where I can obtain castings for the "Seagull" 10 c.c. twin-cylinder engine, and also for the single-cylinder version of this engine. Is there a set of drawings available for the single-cylinder engine? Also, please advise me the approximate overall size and weight of the "Seagull," as I wish to check up on the space available for fitting this to a hull. Please advise me where to obtain castings for the "Kinglet" 5 c.c. four-stroke engine.

H.M.R. (Parkstone).

Castings for the "Seagull" engine can be obtained from Craftsmanship Models Ltd., Norfolk Road Works, Ipswich. We understand they are also able to supply castings for the single-cylinder version, known as the "Seamew." Drawings for the latter engine are incorporated in the drawings of the "Seagull" engine, which are obtainable from our publishing department, or from the above firm, price 6s. 0d. for a set of two sheets. (Reference No. P.E.25.) The dimensions of the "Seagull" twin-cylinder engine are as follows: Height, 4½ in.; length, 5 in.; width, 3 in.; weight, 4½ lb.

Castings for the "Kinglet" are obtainable from G. Kennion & Co., 32, Kingsland Road, London, E.C.3.

Launch-type Expansion Links

I am designing a Stephenson link motion for an inside-cylinder 4-4-0 locomotive in 3½-in. gauge. I want to use launch-type expansion links, but am having difficulty in settling the radius of the link slot. I am told that the radius should be equal to the length of the eccentric rod, but with a launch-type link this length is shorter than it would be for a locomotive-type link. What is the answer to this, and from what point should the curved centre-line of the slot be struck?

A.S.S.V. (Highgate).

The rule that the radius of the link slot is equal to the length of the eccentric-rod is true in the case of the locomotive-type of link only. For a launch-type link, the radius of the link slot is equal to the length of the eccentric-rod, measured from the centre of the eccentric to the centre of the pin which joins the eccentric-rod to the link, plus the distance that the pin is behind the centre-line of the link; this distance is, of course, measured along the centre-line of the eccentric-rod produced to cut the curved centre-line of the link.

To find the centre from which to strike the curved centre-line of the link, set your compass to a radius equal to the distance between the centres of the axle and the eccentric. With this radius, and from the axle centre, draw an arc to cut the centre-line of the motion; the point of this intersection is the true centre of the curved centre-line of the link.

Fabricating Cylinder for C.I. Engine

I am making a small c.i. engine, the cylinder of which has a flange with exhaust ports cut in it, and it also acts as a bolting-down flange. This flange is brazed on to the cylinder barrel. It is proposed to make the cylinder of mild-steel and case-harden it, but the problem arises, if this is case-hardened first will it stand the subsequent brazing heat, or if I braze first, will it stand the hardening heat?

L.B. (Co. Durham).

We suggest that you might use a high-temperature brazing alloy such as used in copper brazing; the temperature at which this fuses will be sufficiently high to enable case-hardening to be carried out without destroying the brazed joint.

We suggest, however, that it would be advisable to carburise the internal surfaces of the cylinder first, so that prolonged heating afterwards will not be necessary, and it could then be quenched out immediately after brazing.

MAKING SMALL BELT PULLEYS

By "Duplex"

ALTHOUGH small pulleys for round or V-belts are, perhaps, most often bought either as castings or in the finished state, they can quite easily be made in the workshop to the exact size of bore and pitch diameter required and, possibly, delay and expense will thereby be saved. Moreover, mild-steel pulleys will wear better than those made of soft alloy.

These constructional notes are, of course, intended for those who have had only limited practical workshop experience.

The simplest form of single pulley, shown on the left of Fig. 1, is machined from mild-steel plate or bar. For a $\frac{3}{16}$ in. dia. round belt, a sewing-machine belt, for example, a thickness of $\frac{3}{8}$ in. will be enough, and this will give the pulley some length of bearing on its shaft. Pulleys for M-type endless V-belts of $\frac{3}{8}$ in. width can be made from $\frac{1}{2}$ in. material.

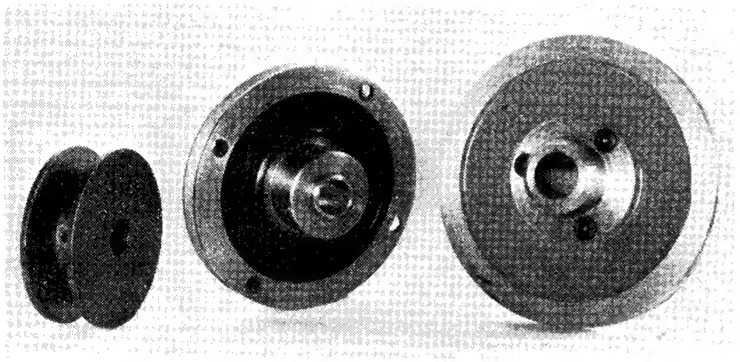


Fig. 1. The three types of belt pulleys described

Where an exact drive ratio is required, as when arranging for a grinding wheel to run at a given speed, the outside diameter of the pulley must first be determined.

The effective diameter of the pulley is measured at the pitch line ; that is to say, when the top of the belt rides level with the top of the pulley groove, the pitch line for both round and V-belts is taken at the half-thickness of the belt, as represented in Fig. 2. Mark-out the pulley accordingly, and dot the scribed lines with a centre-punch. The outside of the pulley can now be cut roughly to shape with the hacksaw and file, and the centre is drilled with a centre-drill.

The blank is next mounted in the four-jaw chuck, with the centre set to run truly, so that the bore can be drilled and afterwards finished to size with a small boring tool.

Making a Stub-mandrel

To ensure that the finished pulley runs truly in relation to its bore, it is mounted on a stub-mandrel, machined in place when gripped in either the four-jaw or the self-centring chuck. Later, when machining the pulley groove, the mandrel will be liable to turn under the pressure of the cut, and many chucks must have been damaged by over-tightening the jaws in an attempt to stop slipping in these circumstances. Some ways of overcoming this difficulty are illustrated in Fig. 3. If hexagonal material is used for making the mandrel (*A*), a three-jaw chuck will give a secure hold ; the grip of the jaws can be increased by using material of large diameter (*B*) ; a driving peg or screw can be fitted to bear against one of the chuck jaws (*C*). Whatever method is used, mark the shank opposite to No. 1 chuck jaw before machining the end to fit the pulley bore. To secure the pulley in place on the mandrel, drill and tap a radial hole in the

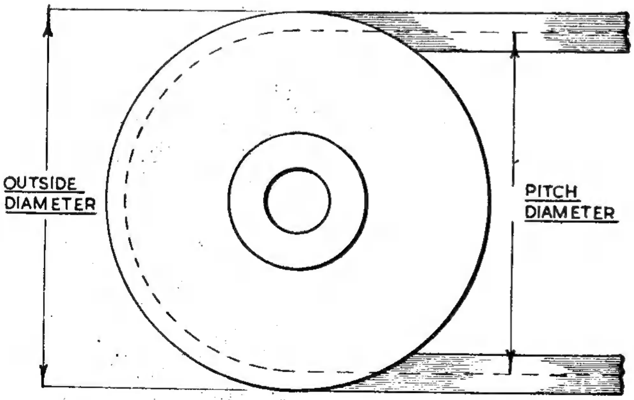


Fig. 2. Measuring the effective diameter of a belt pulley

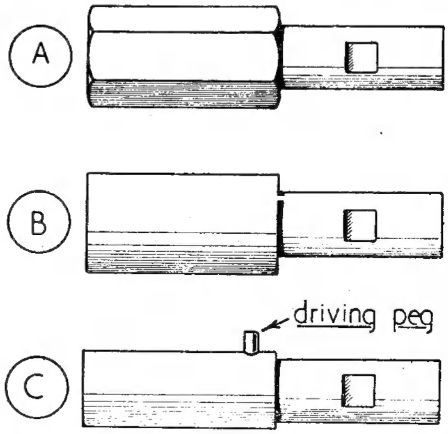


Fig. 3. Three patterns of stub-mandrels

pulley blank and put in a well-buried screw to engage a small flat filed on the mandrel ; if the screw slot is machined away when cutting the groove, there may be some difficulty in removing the screw.

Machining the Pulley Groove

After the pulley has been turned to the finished diameter and the outer surface faced, the inner surface is machined by reversing the pulley on the mandrel.

A convenient way of machining the groove is illustrated in Fig. 4.

A parting tool and a V-tool are mounted in the rear toolpost to enable heavier cuts to be taken without chatter.

The V-tool is ground to an included angle of 30 deg. as this will usually be found a suitable angle for a round belt, and the angles for V-belts, ranging from 30 deg. to 36 deg. or so, can be readily obtained by setting over the tool with the aid of a protractor. The parting tool is first fed in to form a groove deeper than the total depth of the belt, as shown in Fig. 5A ; this is essential to prevent a V-belt bottoming and the fastener of a round belt striking the pulley.

The V-tool is next fed in to take a plunging cut, and first one side of the V and then the other is machined in this way, until the belt is found to lie flush with the outside of the pulley.

The finished pulley can now be fitted to its shaft and secured with an Allen set-screw abutting against a flat or engaging in a keyway.

Small pulleys are sometimes made with a threaded bore to screw against a shoulder on a shaft; the pull of the belt should then be arranged to tighten the pulley in place, but a threaded locking-ring may also be fitted.

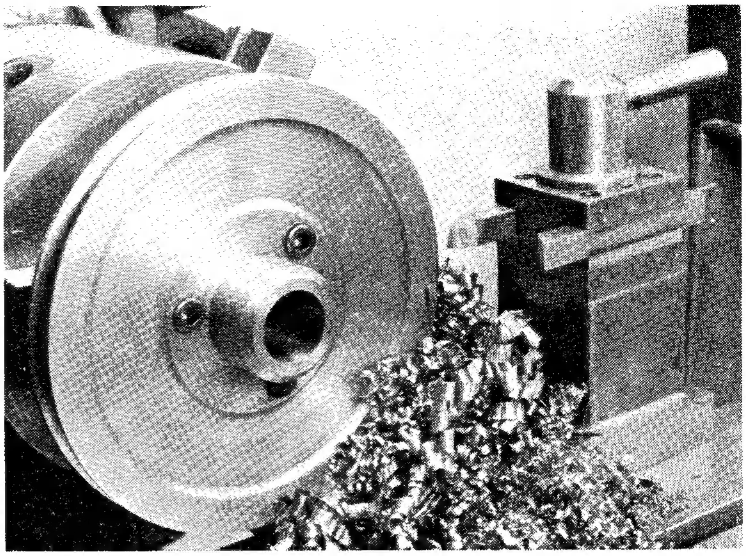


Fig. 4. Machining the pulley groove with two tools mounted in the rear toolpost

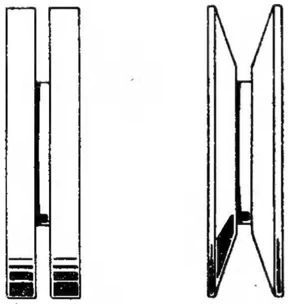


Fig. 5. "A"—the pulley groove machined to the full depth with the parting tool ; "B"—the groove finished with the V-tool

Built-up Pulleys

Larger pulleys require a longer bearing on the shaft, and for this purpose a disc of plate material can be fixed to a central boss for attachment to the shaft. In this way, labour and material can be saved by building up the pulley instead of machining it from the solid.

The pulley illustrated in the centre of Fig. 1 is an example of this method of construction and, as shown in Fig. 6, the disc portion is first turned to fit the shaft and the boss is machined separately, also to a push fit. The two parts are then mounted on a well-fitting rod or mandrel, and either three or four holes are drilled and tapped right through for the assembly-screws. In the alternative arrangement, shown in Fig. 6B, the two parts are centred by turning a register on the boss to fit into a recess machined in the pulley disc. Finally, two set-screws, spaced at 90 deg., are fitted to the boss to engage with flats filed on the shaft. Sometimes, as in Fig. 6C, the boss is lengthened to form a bushing, which is made a force fit for pressing into the pulley. The belt grooves in these built-up pulleys can be machined by mounting the assembled pulley on a stub mandrel.

The pulley illustrated in Fig. 7 and on the right of Fig. 1 is also of the built-up pattern, but the disc portion was made easily detachable, so that different sizes of pulleys

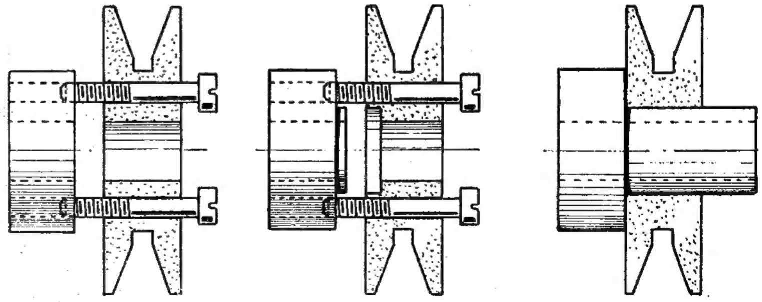


Fig. 6. Three ways of building up small pulleys

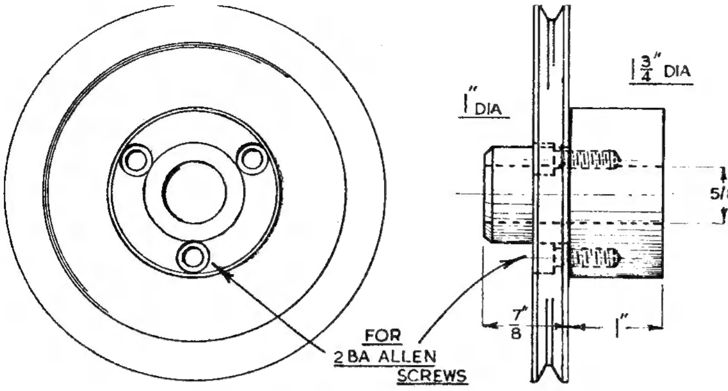


Fig. 7. A shaft mounting with interchangeable pulley discs

could be fitted to a boss remaining permanently attached to the shaft; the boss then affords a square bolting face, as well as an accurate register for the pulley. Recently, when arranging a drive by means of two V-belts running side by side, both the driving and the driven twin-groove pulleys were built up in the way described from pieces of $\frac{3}{8}$-in. steel plate secured to a central boss.

When castings are not available, matched pairs of step-pulleys for round or V-belt drives can be made up from suitable material. As the central boss is not heavily stressed or subjected to wear, it can quite well be turned from duralumin bar in order to afford easier machining.

A Simple Rolling Machine

By E. R. Uphill

ON my 5-in. gauge locomotive that I am building I required six leaf springs made from No. 30-s.w.g. spring-steel; each spring was made up of thirty-three leaves. The finished spring required a set of nine-sixteenths of an inch, which gave a riding position of just off flat.

A few were cut and set by lightly hammering on a small vee-block, but were not very satisfactory, as they took their set in a series of kinks.

So it was decided that to get a uniform set in one-hundred and ninety-eight leaves, a set of rolls would have to be made. They are simple to construct and will prove useful for the odd rolling job in light material.

The base is a $7\frac{7}{8}$in. length of $1\frac{1}{2}$-in. $\times$ $\frac{3}{8}$-in. B.M.S. The side members are two lengths of $1\frac{1}{4}$-in. $\times$ $\frac{1}{2}$-in. B.M.S. squared off to a length of 4 in. in the lathe. The $\frac{3}{8}$-in. slots are end-milled or filed to dimensions; the slot length is not critical, as all adjustments are taken on the screws. The pinch and driving rolls are machined from $\frac{5}{8}$ in. diameter B.M.S. The single rear roll is machined from $\frac{1}{2}$-in. bar.

To use the roller, grip the overhanging part of the base in the vice; the roller should be upside down, so that the rollers drop on to the adjusting screws. Adjust the pinch roll so it just grips the material. Adjust rear roll to impart necessary sweep. If rolling spring-steel, it will be necessary to take the bend in two or three stages.